TECHNICAL REPORT
ENVIRONMENTAL DREDGING AND SEDIMENT DECONTAMINATION TECHNOLOGY DEMONSTRATION PILOT STUDY
LOWER PASSAIC RIVER RESTORATION PROJECT
MAGNETOMETER AND SUB-BOTTOM PROFILER DEBRIS SURVEY

SPONSOR

NEW JERSEY DEPARTMENT OF TRANSPORTATION-OMR
OFFICE OF MARITIME RESOURCES
1035 Parkway Avenue, E&O Building
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Earth Tech
300 Broadcrest Drive
Bloomfield, NJ 07003

SURVEY COMPANY

Aqua Survey Inc.
469 Point Breeze Rd.
Flemington, NJ 08822

ASI Project Number 24-225

December 3, 2004

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DECONTAMINATION TECHNOLOGY DEMONSTRATION
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This report, as well as all records and raw data were audited and found to be an accurate reflection of the study. Copies of raw data will be maintained by Aqua Survey, Inc., 469 Point Breeze Road, Flemington, NJ 08822.

James Nickels **Date**
Vice President and Field Project Manager

James Todd **Date**
Executive Vice President

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I. SUMMARY

The goal of the debris survey was to identify buried objects that may be hazards to the dredging operation in the proposed pilot study area (Figure 1). Both sub-bottom and magnetometer surveys were conducted in an attempt to identify objects buried beneath the surface of the sediment.

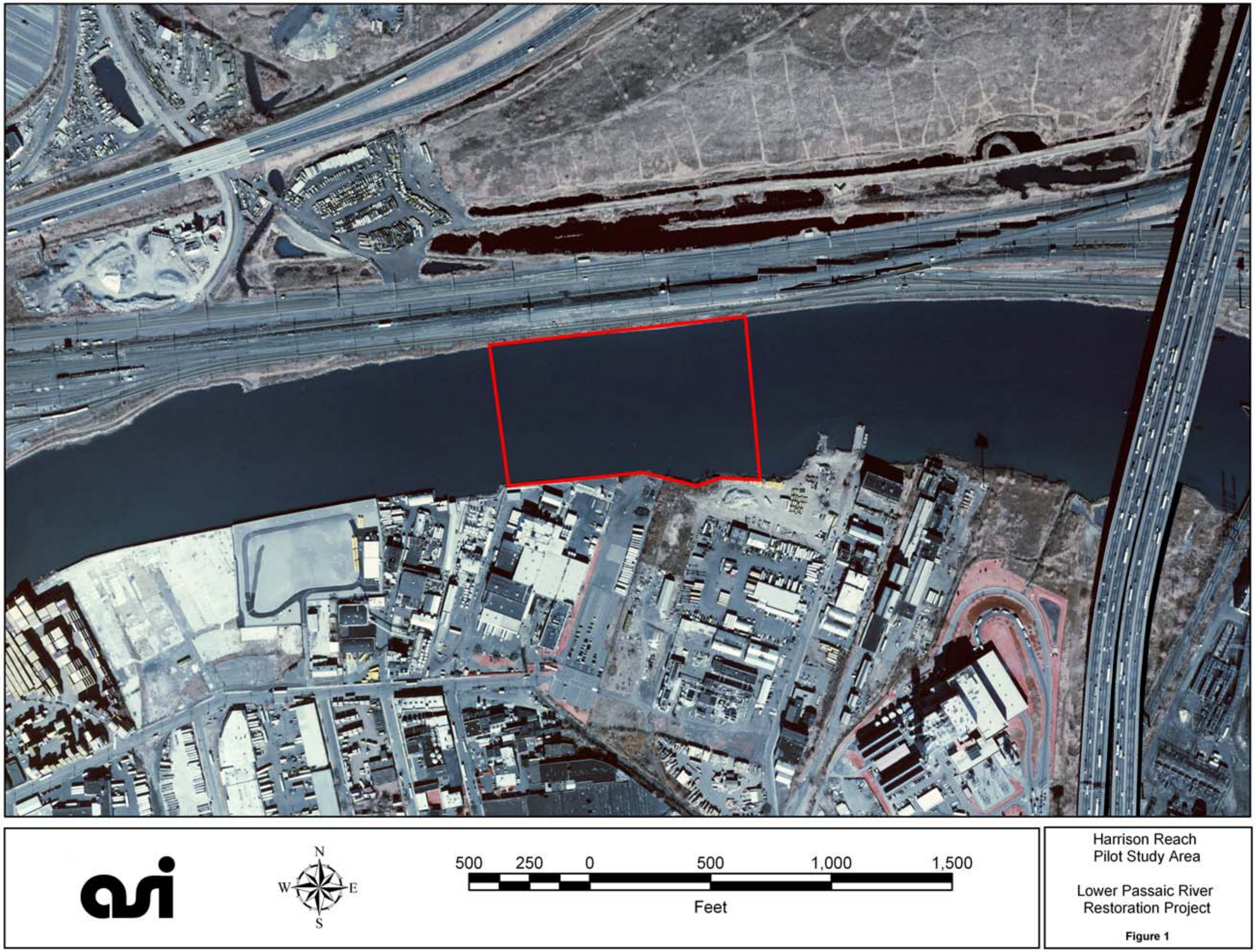
The survey work encompassed the entire river bottom, to the MLW mark along each shoreline. The survey extended for 1000 feet along the river centerline from bank to bank (Figure 1). The survey work was conducted in NAD83 and NJ State Plane feet (horizontal datum) and NGVD 1929 for the vertical datum.

A Geometrics G-882 marine cesium magnetometer system was used for the initial magnetometer survey. During the survey, the sensor was towed at a depth of 1 to 5 feet and approximately 40 feet behind the survey vessel to ensure the sensor was not detecting the vessel itself.

An Edgetech X-STAR chirp sonar system was used with a SB-216S towfish to perform sub-bottom profiling along the Harrison Reach of the Passaic River. During the survey, the SB-216S was towed at a depth between 3 and 6 ft. and approximately 6 ft. aft of the navigational antenna on the port side of the Aqua Survey, Inc. vessel R/V *Delaware.*

Surveys lines were initially surveyed using a magnetometer, then subsequently surveyed using the X-STAR sonar. The magnetometer survey revealed 12 distinct magnetic anomalies as well as significant levels of background geologic interference. Of those 12 targets identified by the magnetometer survey only two could be correlated with reflections in the sub-bottom profiles. In addition to these two targets, two potential targets, not detected in the magnetometer survey, were imaged by the chirp system. Images of the magnetic signatures as well as the four targets observed on the chirp profiles are shown within the text of this report.

None of the targets located were found to have signatures indicative of historically significant submerged cultural resources. Because all of the materials generating the targets are buried below the surface of the sediment, it is impossible to positively identify them using remote sensing equipment. Whether the targets identified are a concern for the future dredging operations cannot be determined. Should the potential exist for the dredging equipment to be damaged by the targets, further investigation may be necessary to determine the nature and depth of burial of the material generating the anomaly. This could be accomplished using jet probing to delineate the size and shape of the object as well as its depth of burial.



Harrison Reach
Pilot Study Area

Lower Passaic River
Restoration Project

Figure 1

II. TEST ADMINISTRATION

A. Sponsor

New Jersey Department of Transportation - OMR
Office of Maritime Resources
1035 Parkway Avenue, E&O Building
Trenton, NJ 08625-0837

B. Survey Company

Aqua Survey Inc.
469 Point Breeze Rd.
Flemington, NJ 08822

C. Dates of Survey

Date of Survey Initiation:	November 10, 2004
Date of Survey Completion:	November 17, 2004

D. Survey Participants

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III. MATERIALS, METHODS, AND RESULTS

A. Magnetometer Data Collection

A magnetometer survey was conducted in order to detect the presence of buried ferrous debris not detected during the side-scan sonar survey. The magnetometer survey also complemented and aided in the interpretation of the side-scan sonar survey results, gathered from a survey in the spring of 2004, regarding debris and potentially significant historic submerged cultural resources. The survey methodology was designed to provide data indicating the position, and relative size of ferrous targets in the survey area, as well as archaeological data essential for complying with the National Historic Preservation Act of 1966, as amended, through 1992 (36 CFR 800, *Protection of Historic Properties*) and the Abandoned Shipwreck Act of 1987 (*Abandoned Shipwreck Act Guidelines*, National Park Service, *Federal Register*, Vol. 55, No. 3, December 4, 1990, pages 50116-50145).

A Geometrics G-882 marine cesium magnetometer system magnetometer capable of plus or minus 0.01 gamma resolution was be used to conduct the survey. Survey lines were run at 25-foot intervals to ensure complete coverage of the survey area. Data was recorded at 0.5 second intervals and electronically paired with positioning data from a real-time kinematic global positioning system using an onboard computer running Hypack Max 4.3 survey software.

To ensure reliable target identification and assessment, analysis of the magnetic data was initially carried out as it is generated. Significant magnetic anomalies were marked as targets during the survey and were re-surveyed using the magnetometer to better determine the size and characteristics of the anomaly.

Post-processing of the data involved examining each survey line individually and annotating anomalies detected. Using contouring software, magnetic data generated during the survey was contour plotted at 10 gamma intervals for analysis and accurate location of the material generating each magnetic anomaly as well as determining the presence of clusters of targets. Magnetic targets were isolated and analyzed in accordance with intensity, duration, areal extent and signature characteristics.

Data generated by the remote sensing equipment was used to support an assessment of each magnetic signature. Analysis of each target signature included consideration of magnetic characteristics previously demonstrated to be reliable indicators of historically significant submerged cultural resources. Assessment of each target includes recommendations for additional investigation to determine the exact nature of the cultural material generating the signature and its potential National Register significance. All targets are listed and described and a map has been produced that shows their location within the project area (Figure X).

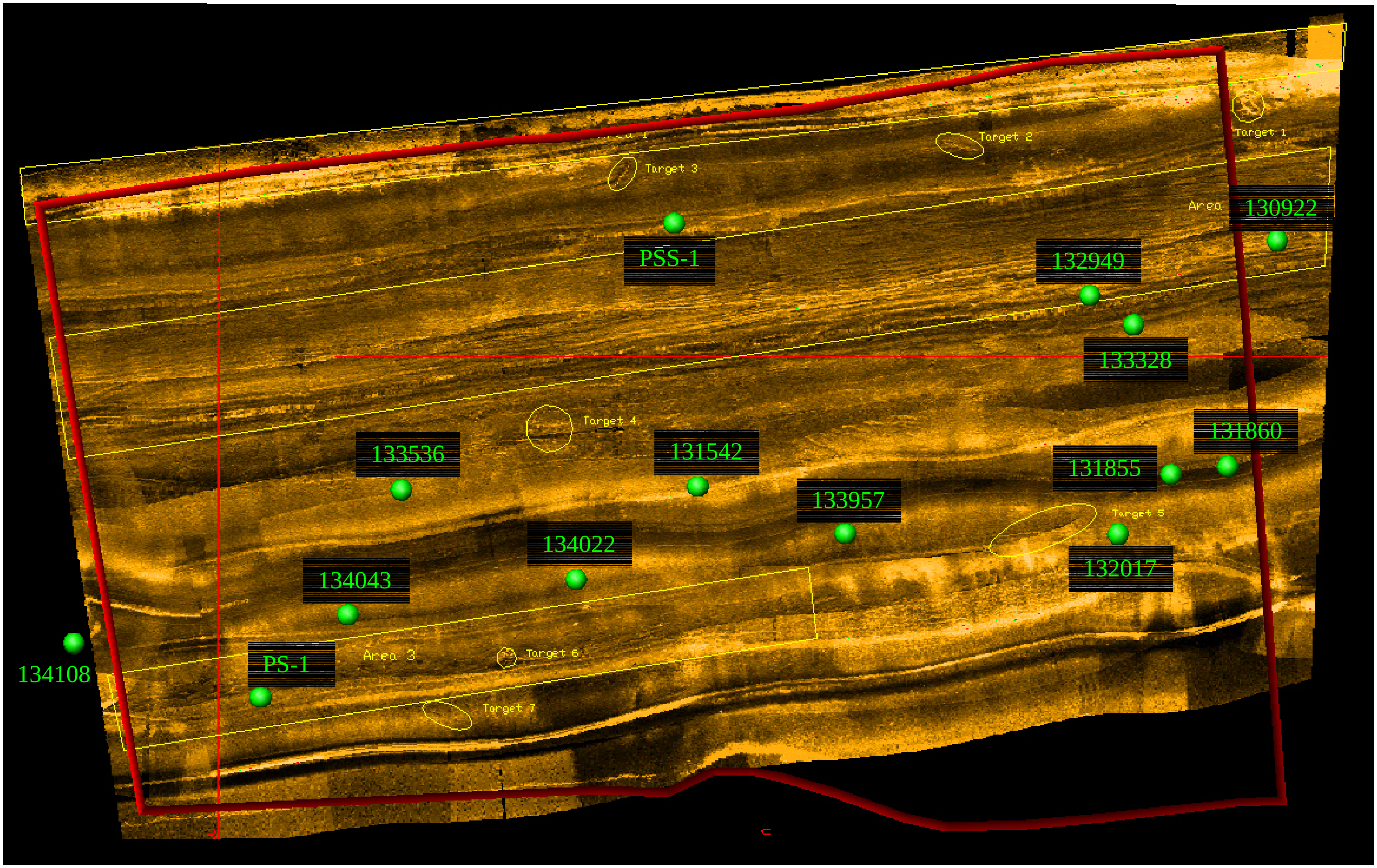


Figure 2. Locations of magnetic anomalies and sub-bottom profiler targets overlaid on side-scan sonar targets and mosaic. Yellow labeled targets are from the side-scan sonar survey. Green labeled targets are from the magnetometer/sub-bottom survey.

B. Magnetometer Results

A Geometrics G-882 marine cesium magnetometer system was used for the magnetometer survey. During the survey, the sensor was towed at a depth of 1 to 5 feet and approximately 40 feet behind the survey vessel to ensure the sensor was not detecting the vessel itself. The magnetometer survey revealed 12 distinct magnetic anomalies as well as significant levels of background geologic interference. The location of each of the magnetic anomalies was checked on the side-scan sonar mosaic and no targets were duplicated in the two surveys.

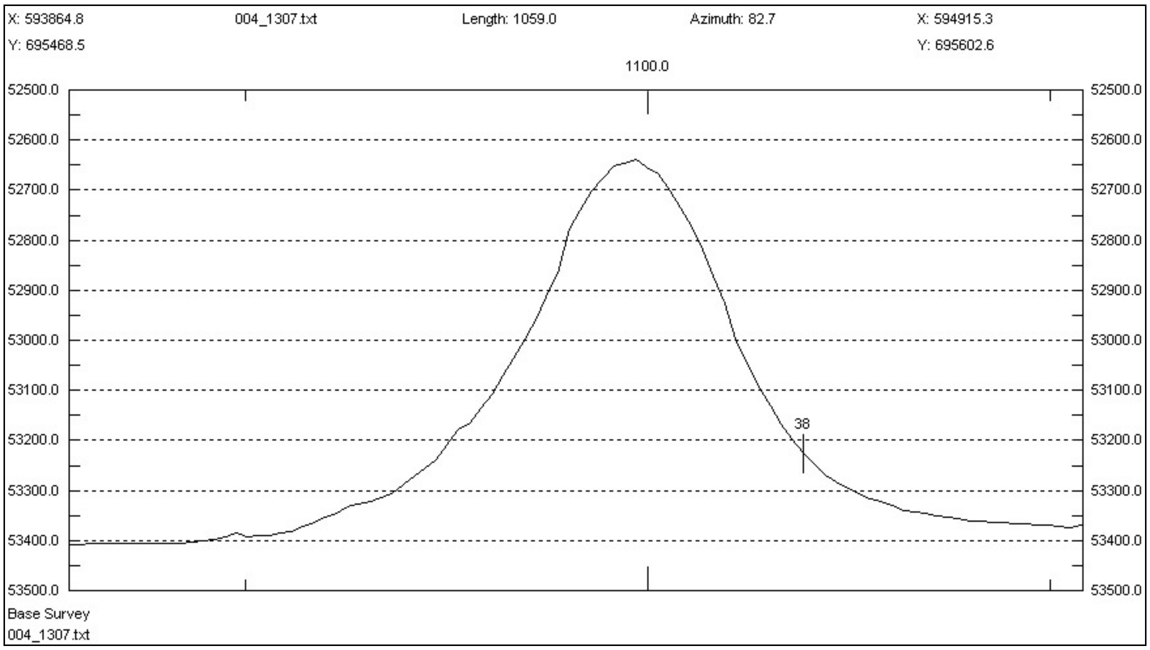


Figure 3. Magnetic signature 130922.

Target Designation	**Easting**	**Northing**	**Gammas**	**Duration**
130922	594953.5	695603.9	1132	100’

The magnetic signature was identified on lane 4. The target is located just outside the eastern edge of study area by 35 feet, but was marked due to its intensity. The location of this target is shown in figure 2. The detectable monopolar negative signature had a maximum intensity of 1132 gammas and was detected for 100 linear feet. Analysis of the magnetic signature suggests that material generating the anomaly is associated with a single large ferrous object and does not represent the complex type of signature generally associated with shipwreck sites. The magnetic anomaly does not correspond to any targets detected in the earlier side-scan sonar survey. The signature was not found to have characteristics indicative of historically significant submerged cultural resources.

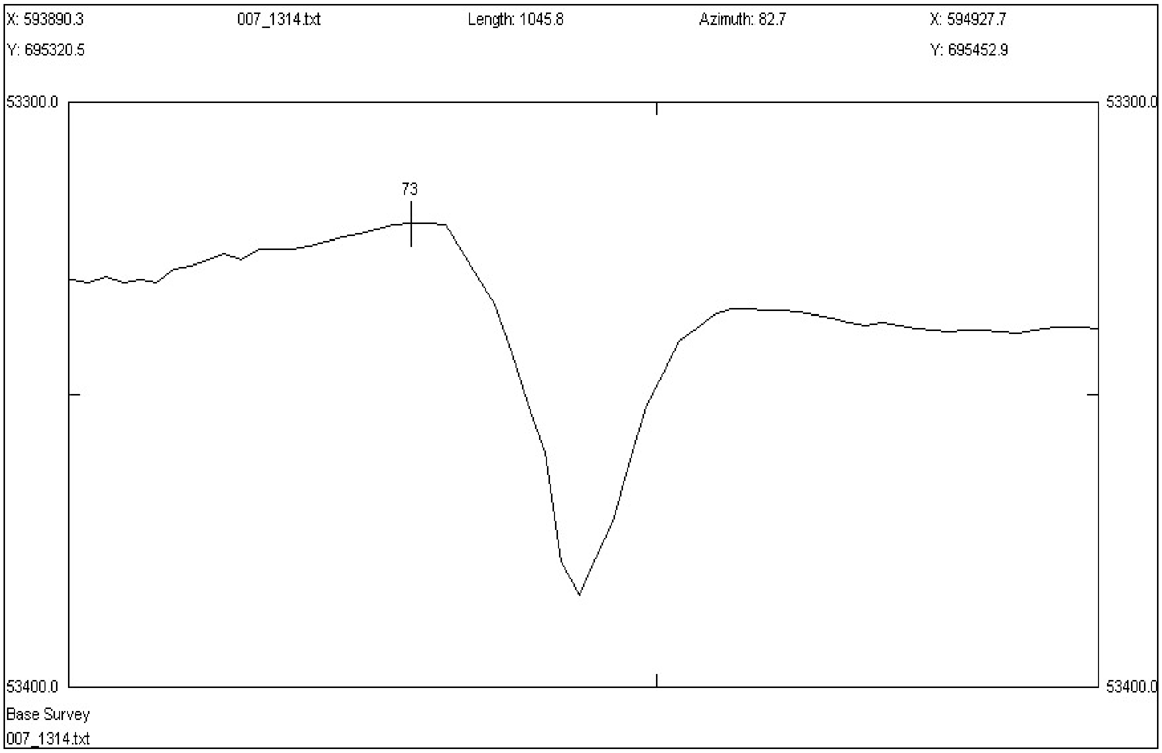


Figure 4. Magnetic signature 131542.

Target Designation	**Easting**	**Northing**	**Gammas**	**Duration**
131542	594431.5	695382.4	64.4	20’

The magnetic signature was identified on lane 7. The location of this target is shown in figure 2. The detectable monopolar positive signature had a maximum intensity of 64.4 gammas and was detected for 20 linear feet. Analysis of the magnetic signature suggests that material generating the anomaly is associated with a single small ferrous object and does not represent the complex type of signature generally associated with shipwreck sites. The magnetic anomaly does not correspond to any targets detected in the earlier side-scan sonar survey. The signature was not found to have characteristics indicative of historically significant submerged cultural resources.

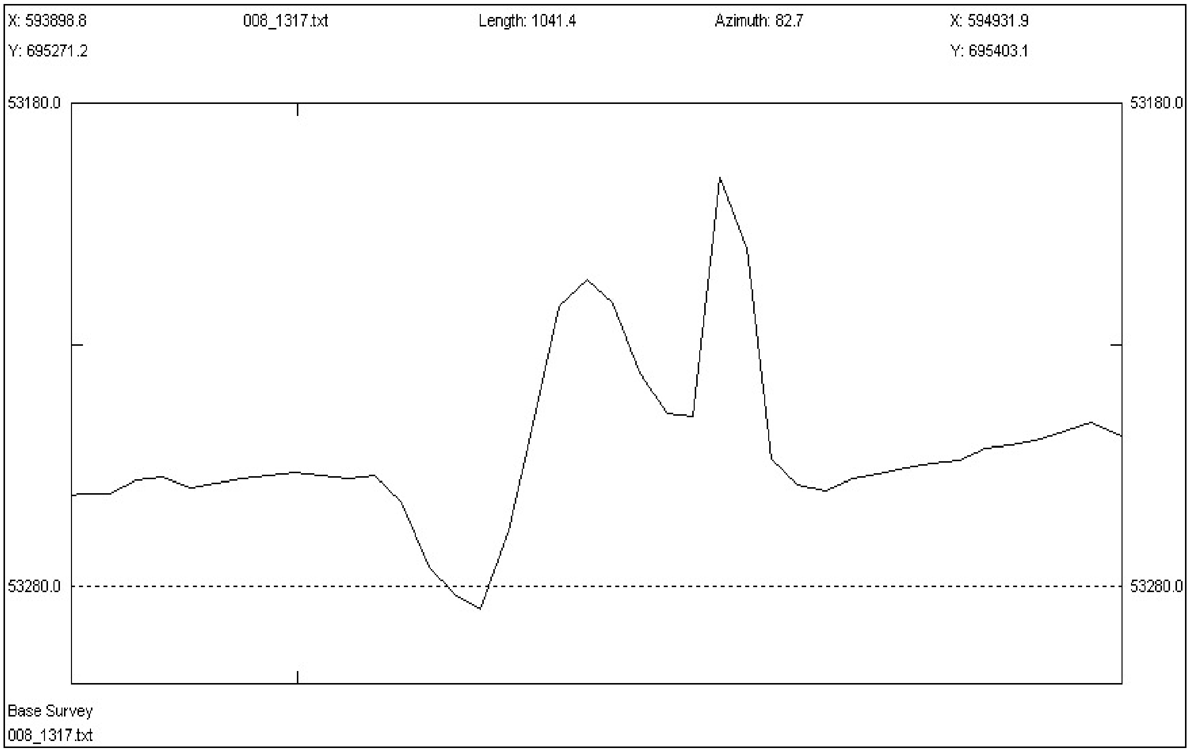


Figure 5. Magnetic signature 131855.

Target Designation	**Easting**	**Northing**	G**ammas**	**Duration**
131855	594857.7	695393.4	89.7	22’

The magnetic signature was identified on lane 8. The location of this target is shown in figure 2. The detectable multicomponent signature had a maximum intensity of 89.7 gammas and was detected for 22 linear feet. Analysis of the magnetic signature suggests that material generating the anomaly is associated with a single small ferrous object or group of small objects such as an anchors, pipes, chain, or wire rope and does not represent the complex type of signature generally associated with shipwreck sites. The magnetic anomaly does not correspond to any targets detected in the earlier side-scan sonar survey. The signature was not found to have characteristics indicative of historically significant submerged cultural resources.

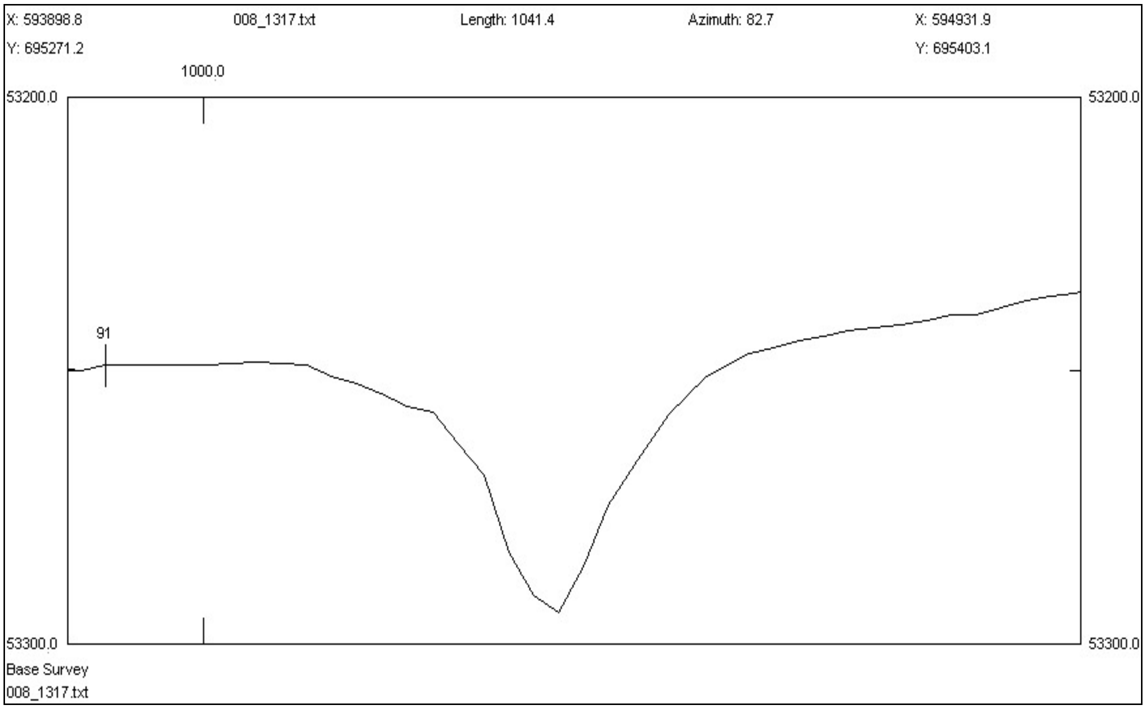


Figure 6. Magnetic signature 131860.

Target Designation	Easting	Northing	Gammas	Duration
131860	594908.8	695400.2	46.0	24’

The magnetic signature was identified on lane 8. The location of this target is shown in figure 2. The detectable monopolar positive signature had a maximum intensity of 46.0 gammas and was detected for 24 linear feet. Analysis of the magnetic signature suggests that material generating the anomaly is associated with a single small ferrous object such as an anchor, pipe, chain, or wire rope and does not represent the complex type of signature generally associated with shipwreck sites. The magnetic anomaly does not correspond to any targets detected in the earlier side-scan sonar survey. The signature was not found to have characteristics indicative of historically significant submerged cultural resources.

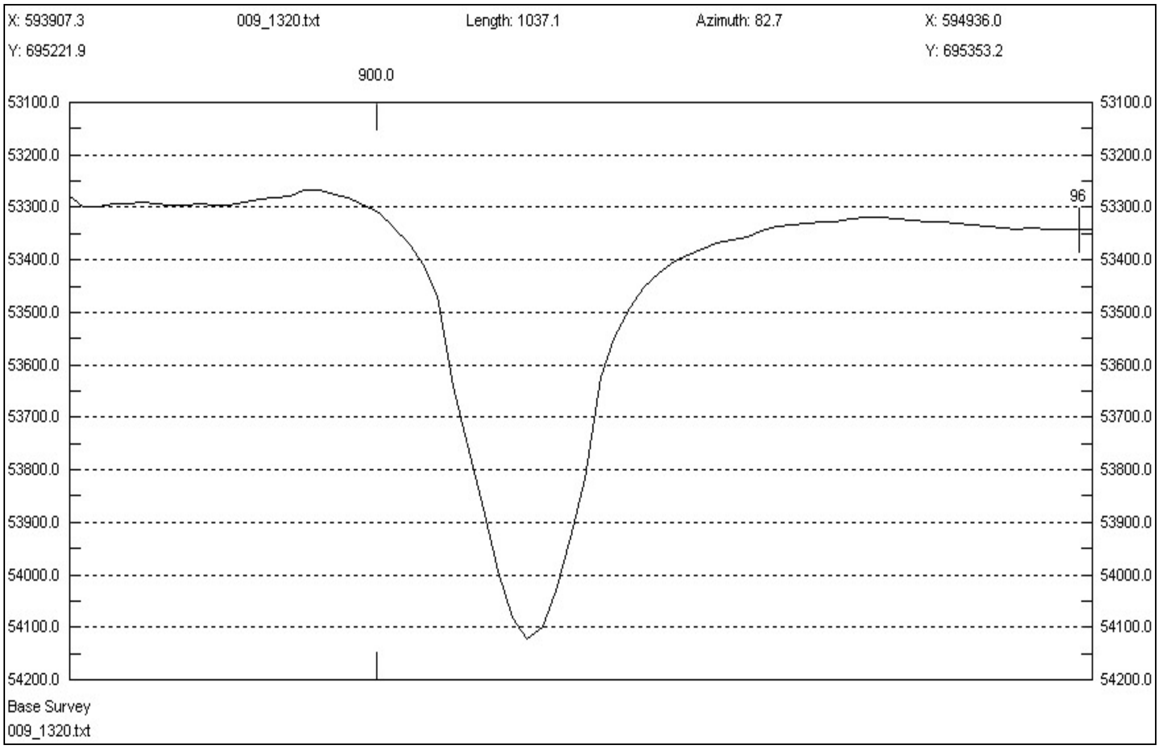


Figure 7. Magnetic signature 132017.

Target Designation	**Easting**	**Northing**	**Gammas**	**Duration**
132017	594810.0	695339.5	852.6	32'

The magnetic signature was identified on lane 9. The location of this target is shown in figure 2. The detectable monopolar positive signature had a maximum intensity of 852.6 gammas and was detected for 32 linear feet. Analysis of the magnetic signature suggests that material generating the anomaly is associated with a single large ferrous object and does not represent the complex type of signature generally associated with shipwreck sites. The magnetic anomaly does not correspond to any targets detected in the earlier side-scan sonar survey. The signature was not found to have characteristics indicative of historically significant submerged cultural resources.

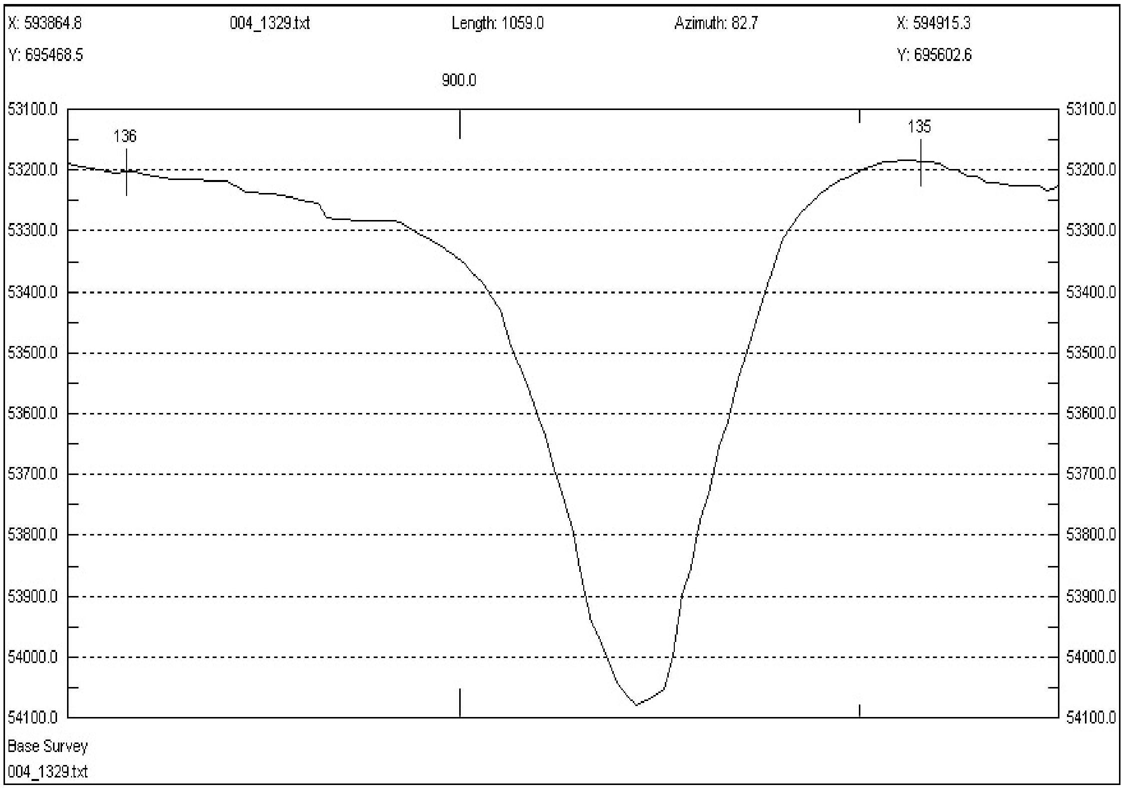


Figure 8. Magnetic signature 132949.

Target Designation	Easting	Northing	Gammas	Duration
132949	594784.7	695554.4	893.1	73’

The magnetic signature was identified on lane 4.5. The location of this target is shown in figure 2. The detectable monopolar positive signature had a maximum intensity of 893.1 gammas and was detected for 73 linear feet. Analysis of the magnetic signature suggests that material generating the anomaly is associated with a single large ferrous object and does not represent the complex type of signature generally associated with shipwreck sites. The magnetic anomaly does not correspond to any targets detected in the earlier side-scan sonar survey. The signature was not found to have characteristics indicative of historically significant submerged cultural resources.

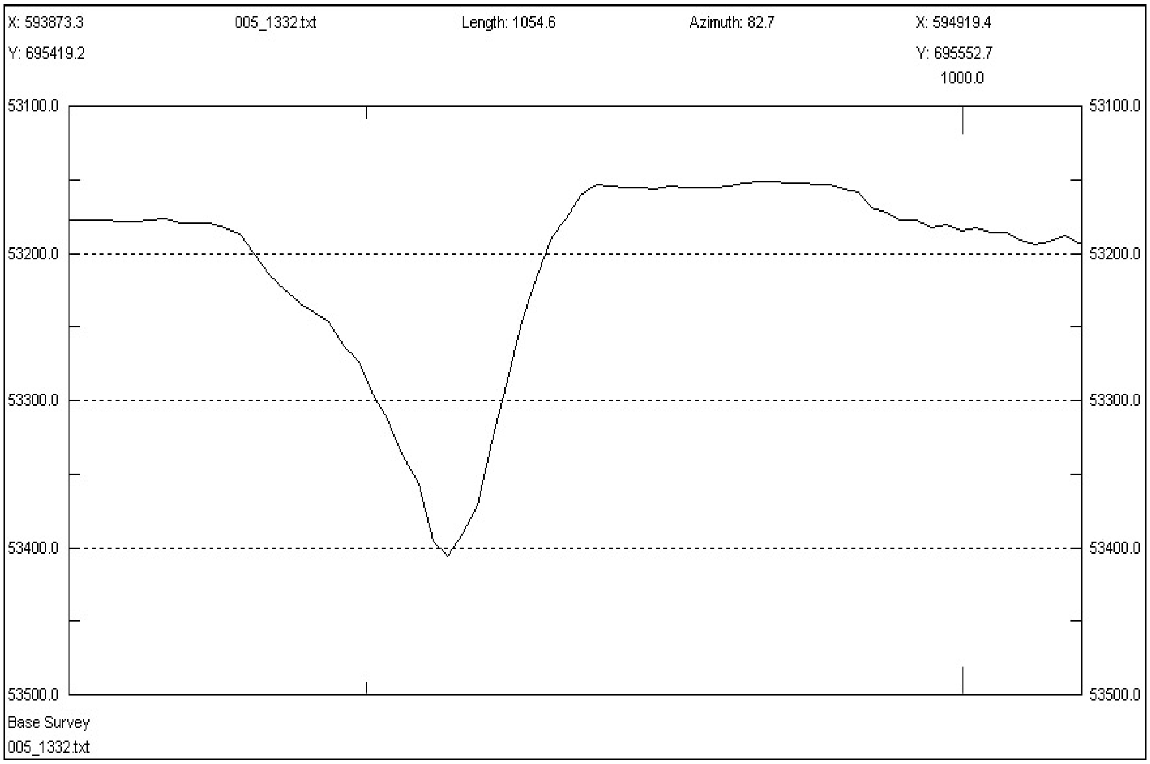


Figure 9. Magnetic signature 133328.

Target Designation	**Easting**	**Northing**	**Gammas**	**Duration**
133328	594824.0	695528.1	202.3	33’

The magnetic signature was identified on lane 5.5. The location of this target is shown in figure 2. The detectable monopolar positive signature had a maximum intensity of 202.3 gammas and was detected for 33 linear feet. Analysis of the magnetic signature suggests that material generating the anomaly is associated with a single ferrous object such as an anchor, pipe, chain, or wire rope and does not represent the complex type of signature generally associated with shipwreck sites. The magnetic anomaly does not correspond to any targets detected in the earlier side-scan sonar survey. The signature was not found to have characteristics indicative of historically significant submerged cultural resources.

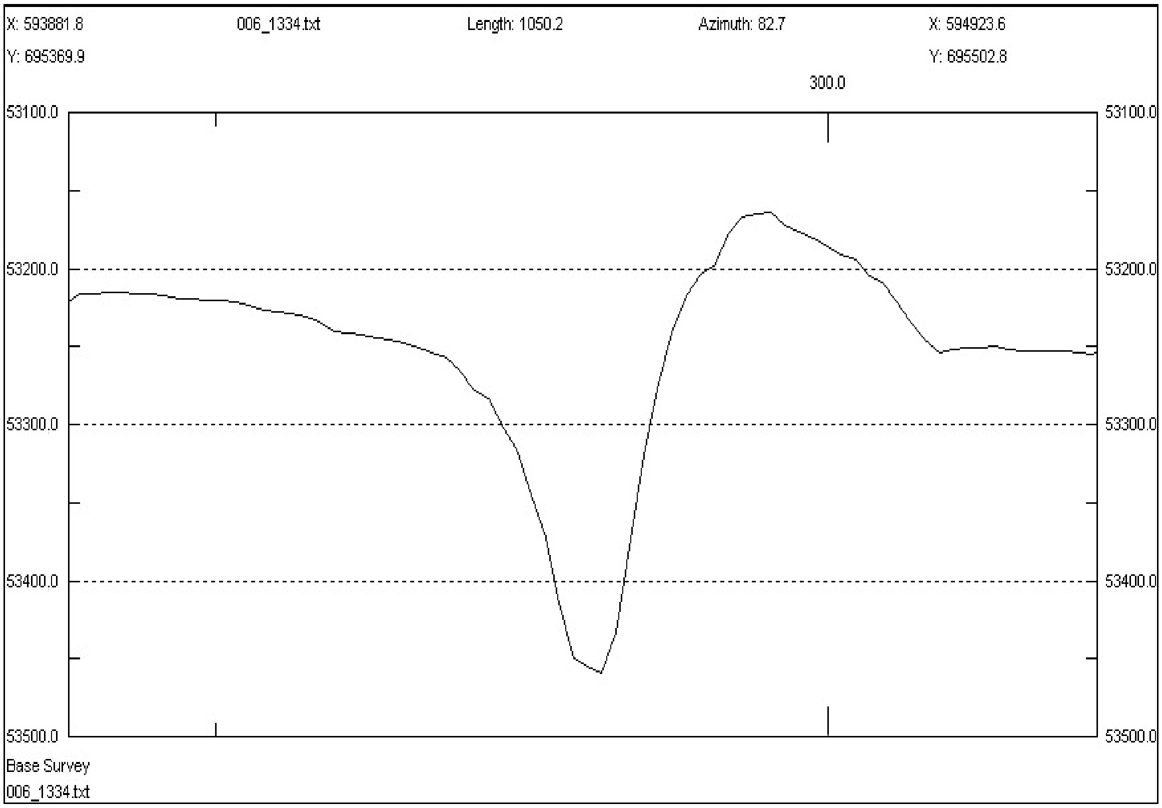


Figure 10. Magnetic signature 133536.

Target Designation	**Easting**	**Northing**	**Gammas**	**Duration**
133536	594164.4	695379.1	293	50’

The magnetic signature was identified on lane 6.5. The location of this target is shown in figure 2. The detectable dipolar signature had a maximum intensity of 293 gammas and was detected for 50 linear feet. Analysis of the magnetic signature suggests that material generating the anomaly is associated with a single small ferrous object such as a pipe or length of wire rope or chain and does not represent the complex type of signature generally associated with shipwreck sites. The magnetic anomaly does not correspond to any targets detected in the earlier side-scan sonar survey. The signature was not found to have characteristics indicative of historically significant submerged cultural resources.

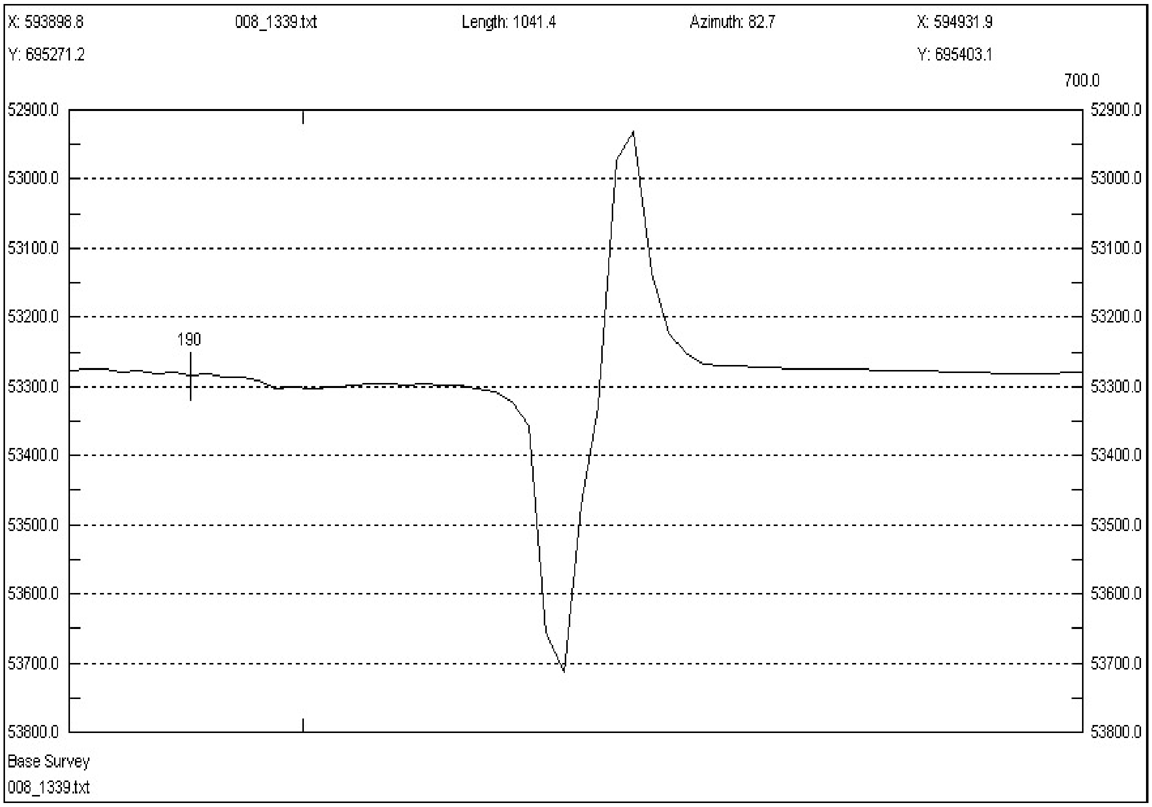


Figure 11. Magnetic signature 133957.

Target Designation	Easting	Northing	Gammas	Duration
133957	594564.4	69539.9	775.2	18’

The magnetic signature was identified on lane 8.5. The location of this target is shown in figure 2. The detectable dipolar signature had a maximum intensity of 775.2 gammas and was detected for 18 linear feet. Analysis of the magnetic signature suggests that material generating the anomaly is associated with a single ferrous object and does not represent the complex type of signature generally associated with shipwreck sites. The magnetic anomaly does not correspond to any targets detected in the earlier side-scan sonar survey. The signature was not found to have characteristics indicative of historically significant submerged cultural resources.

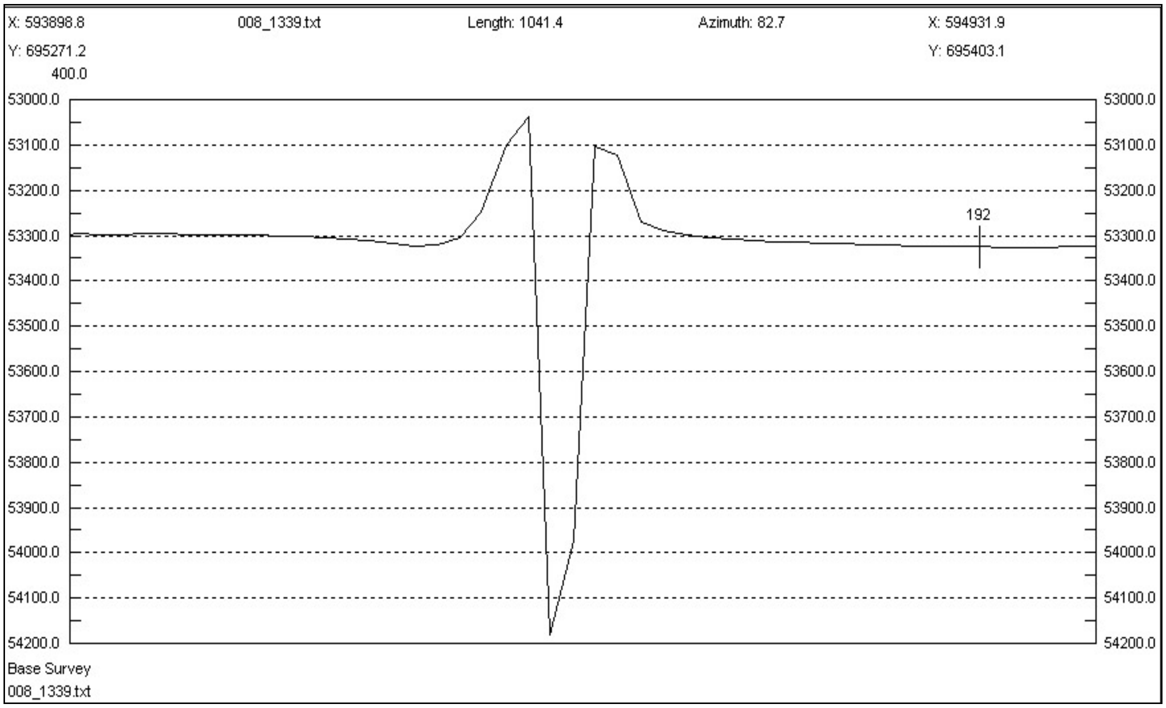


Figure 12. Magnetic signature 134022.

Target Designation	**Easting**	**Northing**	**Gammas**	**Duration**
134022	594322.1	695298.5	1153	18’

The magnetic signature was identified on lane 8.5. The location of this target is shown in figure 2. The detectable multicomponent signature had a maximum intensity of 1153 gammas and was detected for 18 linear feet. Analysis of the magnetic signature suggests that material generating the anomaly is associated with a single ferrous object such as a coil of wire rope or chain and does not represent the complex type of signature generally associated with shipwreck sites. The magnetic anomaly does not correspond to any targets detected in the earlier side-scan sonar survey. The signature was not found to have characteristics indicative of historically significant submerged cultural resources.

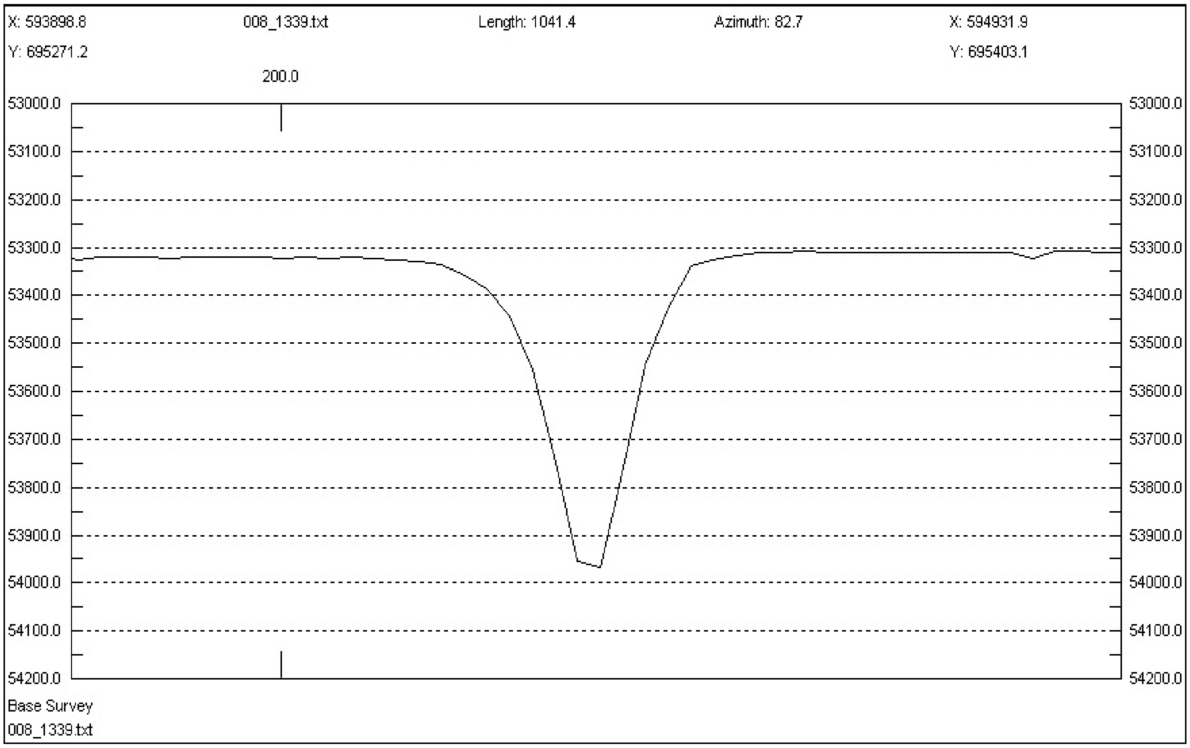


Figure 13. Magnetic signature 134043.

Target Designation	Easting	Northing	Gammas	Duration
134043	594116.3	695267.0	662.4	20’

The magnetic signature was identified on lane 8.5. The location of this target is shown in figure 2. The detectable monopolar positive signature had a maximum intensity of 662.4 gammas and was detected for 20 linear feet. Analysis of the magnetic signature suggests that material generating the anomaly is associated with a single ferrous object and does not represent the complex type of signature generally associated with shipwreck sites. The magnetic anomaly does not correspond to any targets detected in the earlier side-scan sonar survey. The signature was not found to have characteristics indicative of historically significant submerged cultural resources.

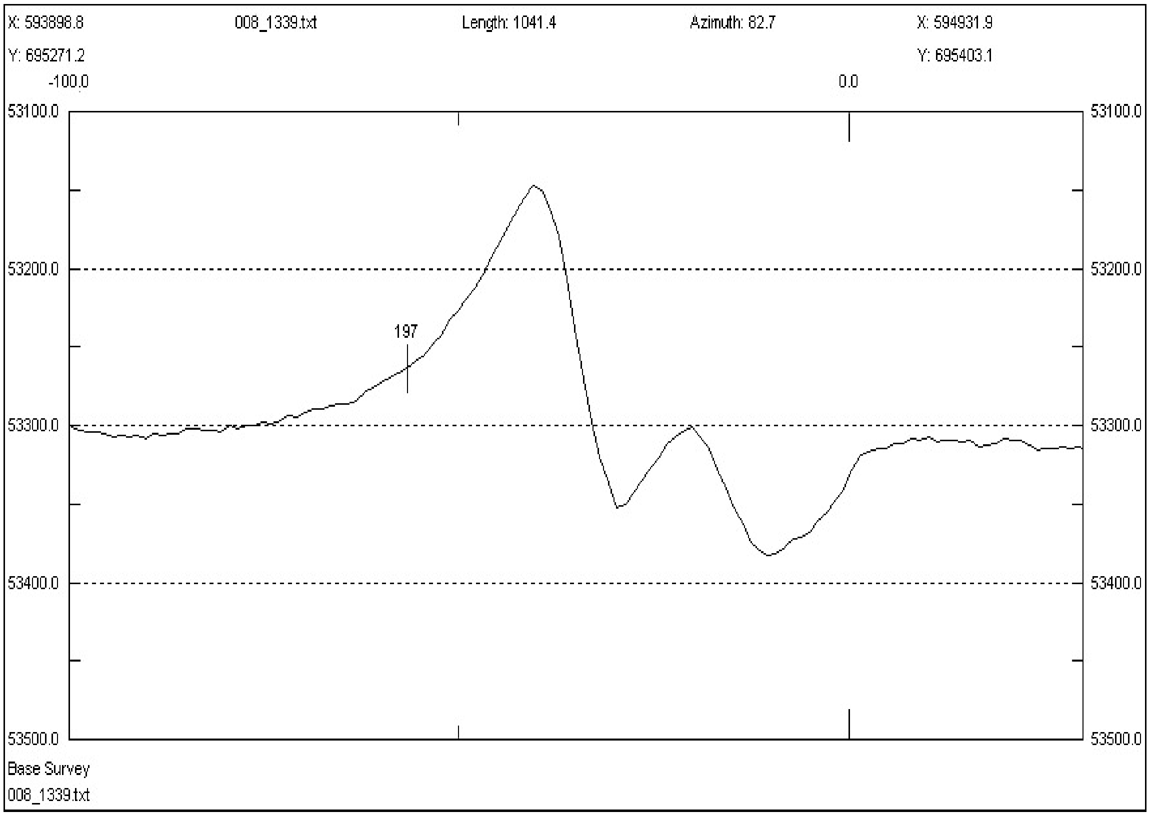


Figure 14. Magnetic signature 134108.

Target Designation	Easting	Northing	Gammas	Duration
134108	593869.4	695241.1	235	77’

The magnetic signature was identified on lane 8.5. The location of this target is shown in figure 2. The target is located just outside the western edge of study area by 32 feet, but was marked due to its intensity. The detectable multicomponent signature had a maximum intensity of 235 gammas and was detected for 77 linear feet. Analysis of the magnetic signature suggests that material generating the anomaly is associated with a single or small group of ferrous objects such as wire rope, chain, pipe, or anchors and does not represent the complex type of signature generally associated with shipwreck sites. The magnetic anomaly does not correspond to any targets detected in the earlier side-scan sonar survey. The signature was not found to have characteristics indicative of historically significant submerged cultural resources.

Figure 15. Edgetech X-STAR sonar system. SB-216S towfish is shown on the left and topside amplifier, computer monitor, and digital recording system is shown on the right.

C. Sub-Bottom Profiler Data Collection

An Edgetech X-STAR sonar system with a SB-216S towfish (Figure 1) was used to collect the chirp sub-bottom profiling data during a survey along the Harrison Reach of the Passaic River. The principal objective of the survey was to collect chirp images along lines that had been previously surveyed with a magnetometer.

Chirp profilers use acoustic methods to generate high-resolution (on the order of 0.5-1 ft) cross-sectional images of the marine sub-bottom to depths of up to 100 ft beneath the seafloor. These profilers transmit a wide band FM sound pulse that is linearly swept over a full spectrum frequency range (i.e., a "chirp"). The transmitted sound pulses travel through the water column and sub-bottom and are reflected when changes in acoustic impedance (equivalent to a material's sonic velocity times its density) are encountered. Acoustic impedance changes commonly occur at boundaries between materials (e.g., interfaces between water and sediments, sediments and gas, and sediments and buried objects). The reflected sound pulses travel back to the profiler where their amplitudes, as a function of travel-time, are digitally recorded.

During the survey, the SB-216S was towed at a depth between 3 and 6 ft. It was towed approximately 6 ft aft of the navigational antenna on the port side of the Aqua Survey, Inc. vessel *Delaware*. The SB-216S emitted a chirp sound pulse with a frequency range of 2-15 kHz, eight times per second. Given this sampling interval with an average speed of 1 to 2 knots, the horizontal spacing between individual pulses displayed on the chirp profiles was on the order of 0.2-0.5 ft.

Geographic position (i.e., latitude and longitude) along the chirp profiles was determined with Trimble RTK Positioning System (Model # 5700). The data from the RTK were also used by the HYPACK helm guidance and position recording software. These navigational data were logged at one-second intervals by HYPACK and the X-STAR digital recording system.

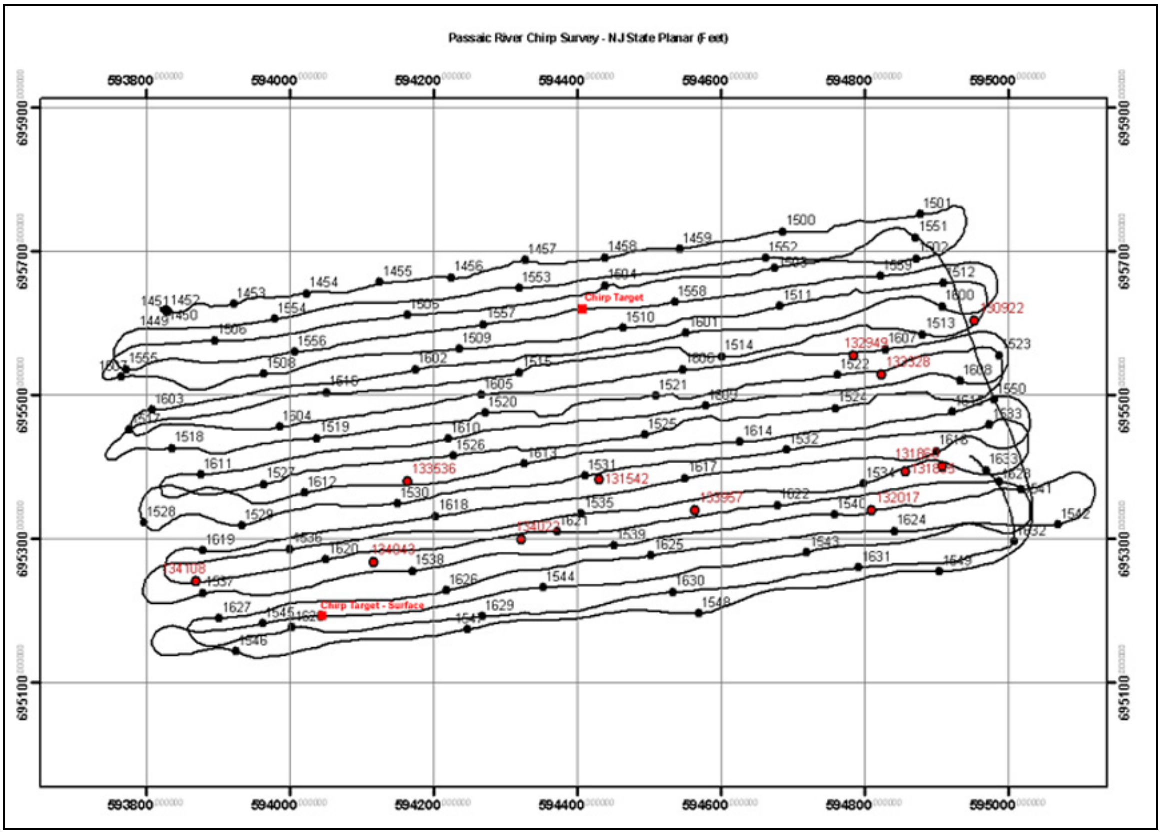


Figure 16. Track lines of the *Delaware* during the chirp survey. Black circles are one-minute time (in GMT) marks along the track lines. Red circles are targets identified during the magnetics survey. Chirp reflections could be correlated with targets 132949 and 133328. Red rectangle denotes target that was identified on the chirp profiles that was not associated with a corresponding magnetic anomaly.

To correct the navigational data to the position of the SB-216S, we estimated its layback (distance aft of the navigational antenna) during the survey while at the average towing speed of 1-2 knots. This distance of about 6 ft was used to correct the SB-216S position relative to the navigation data. The navigational data for the targets identified in the earlier magnetics survey and their corresponding positions along the chirp profiles are presented in Table 1 along with one potential target identified in the chirp data that was not associated with a magnetic anomaly. Along the chirp profiles, the position of the magnetics targets were identified as either the closest profile position to the target (i.e., in the case that the target was not associated with reflections in the chirp data) or the central geographic co-ordinates of the chirp reflections that corresponded with a target. For the targets associated with chirp reflections, the positional information (i.e., WGS84 latitude and longitude as logged by the RTK system) was calculated from the Edgetech data screen during playback. These points were then translated into NAD83 New Jersey State Plane eastings and northings in feet. The estimate of the positional accuracy of the RTK system is 1 to 3 cm. The estimation for the layback error is 1 to 2 ft. Adding the two potential errors generates an error estimate of 1 to 2 ft in the definition of the geographic location of the identified targets.

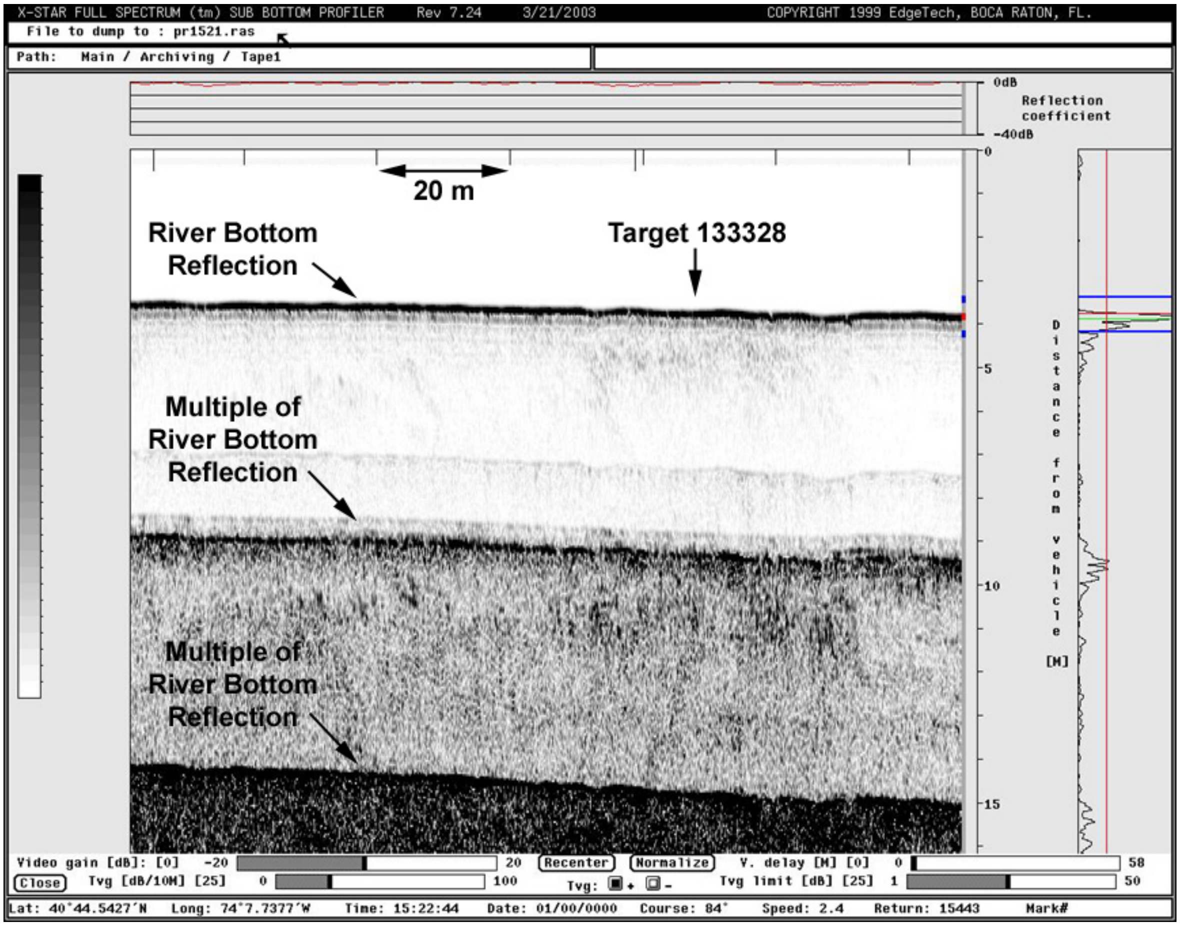


Figure 17. Example of computer monitor "real-time" chirp system output. A series of reflections, as a function of depth beneath the towfish, are shown in the center. The strength of the river bottom reflection (shown along top) and sub-bottom events (shown to the right) are also displayed. Along the bottom, RTK derived position, time, course, and speed are shown.

During the survey, the data were observed in "real-time" on the X-STAR monitor (Figure 3). The data displayed included the reflection coefficient of the river bottom (a measure of the acoustic impedance contrast at the water/sediment interface), the relative amplitude of bottom and sub-bottom reflections, a cross-sectional image of the last ~600 chirp pulses that were recorded, as well as the current position, time, date, course and speed of the R/V *Delaware*.

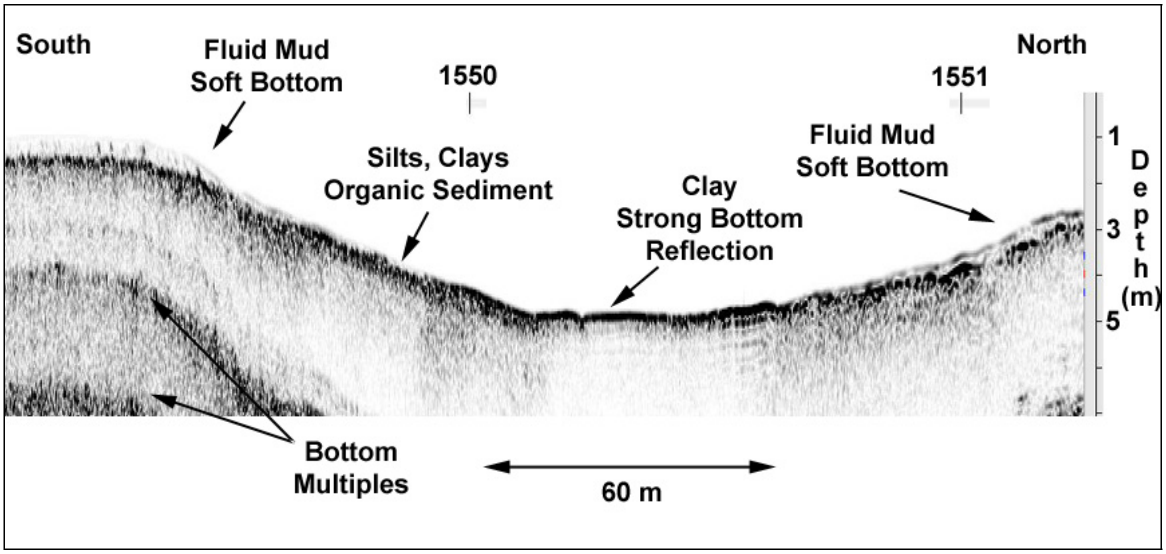


Figure 18. Chirp profile collected across the Harrison Reach of Passaic River. Depths are below towfish in meters. 1550 and 1551 denote time in minutes (GMT). The position of this track line is shown in Figure 2. The presence gas in organic, gassy sediments and well-consolidated silt/clay sediments along the river bottom prevented the significant penetration of the chirp acoustic signal.

D. Sub-bottom Profiler Results

As shown in Figure 4, three major types of bottom sediments were encountered during the chirp survey. In shallower water depths along the edges of the channel of the Passaic River, a soft bottom characterized by fluid muds at the sediment water interface with underlying organic fine-grained sediments was imaged by the chirp system. The underlying fine-grained sediments were associated with a high-amplitude chirp reflection most likely due to gas contained within these sediments. Along the slopes of the channel, gassy silt and clay organic-rich sediments were present. The presence of gas, most likely produced by the decay of organic material within the sediments reduces the penetration of the chirp acoustic signals. In the deepest portions of the river along the channel, well-consolidated silt and clay sediments with gas produced a high amplitude reflection at the sediment/water interface. This strong reflection reduced the amount of chirp energy that could penetrate further into the subsurface.

Target Number	Target ID	Magnetics Target Position	Target Dist. From Chirp Track	Chirp Target Position	Comments
1	130922	594953.5E 695603.9N	3.4’	594955.5E 695601.7N	Not imaged by chirp
2	131542	594431.5E 695382.4N	9.4’	594429.5E 695391.4N	Not imaged by chirp
3	131855	594857.7E 695393.4N	6.6’	594854.9E 695399.6N	Not imaged by chirp
4	131860	594908.8E 695400.2N	6.2’	594910.8E 695405.7N	Not imaged by chirp
5	132017	594810.0E 695339.5N	1.2’	594810.2E 695338.5N	Not imaged by chirp
6	132949	594784.7E 695554.4N	5.2’	594784.2E 695559.6N	Imaged by chirp
7	133328	594824.0E 695528.1N	4.8’	594822.8E 695533.2N	Imaged by chirp
8	133536	594164.4E 695379.1N	4.4’	594165.0E 695374.9N	Not imaged by chirp
9	133957	594564.4E 695339.9N	8.5’	594566.5E 695331.5N	Not imaged by chirp
10	134022	594322.1E 695298.5N	8.8’	594320.0E 695307.2N	Not imaged by chirp
11	134043	594116.3E 695267.0N	11.8’	594117.7E 695254.8N	Not imaged by chirp
12	134108	593869.4E 695241.1N	1.8’	593870.0E 695239.6N	Not imaged by chirp
13	PSS-1	-	-	594410.4E 695619.5N	Not detected by magnetics. Potential sub-surface target
14	PS-1	-	-	594037.7E 695192.3N	Not detected by magnetics. Potential surface target

Table 1. Targets as identified by magnetic and chirp surveys. All positions are NAD New Jersey State Plane eastings and northings in feet. If the chirp did not image the target, the position as listed in the table is the central location where chirp profiles were examined for reflections associated with targets.

The presence of gaseous sediments and well-consolidated sediments along the river bottom prevented the penetration of acoustic signals deeper into the sub-bottom and thus limited the effectiveness of the chirp system during the survey. Although the chirp system acoustic signal was able to penetrate in a few areas and image a few targets, overall the sediments present in the survey area severely limited the acoustic imaging efforts. Due to these gaseous sediments only two targets identified during the magnetometer survey were partially imaged by the sub-bottom system. Two other targets were recorded setting the total number of observed target at four (Figures 5-8). Of the two targets that were not associated with magnetic signals, one was observed at the surface (identified as potential target – surface) and was characterized by a high-amplitude, rather square-shaped reflection (Figure 5). The second target (identified as potential target – sub-surface) was characterized by reflections that ranged in depth from 3 to 10 ft beneath the surface (Figure 6).

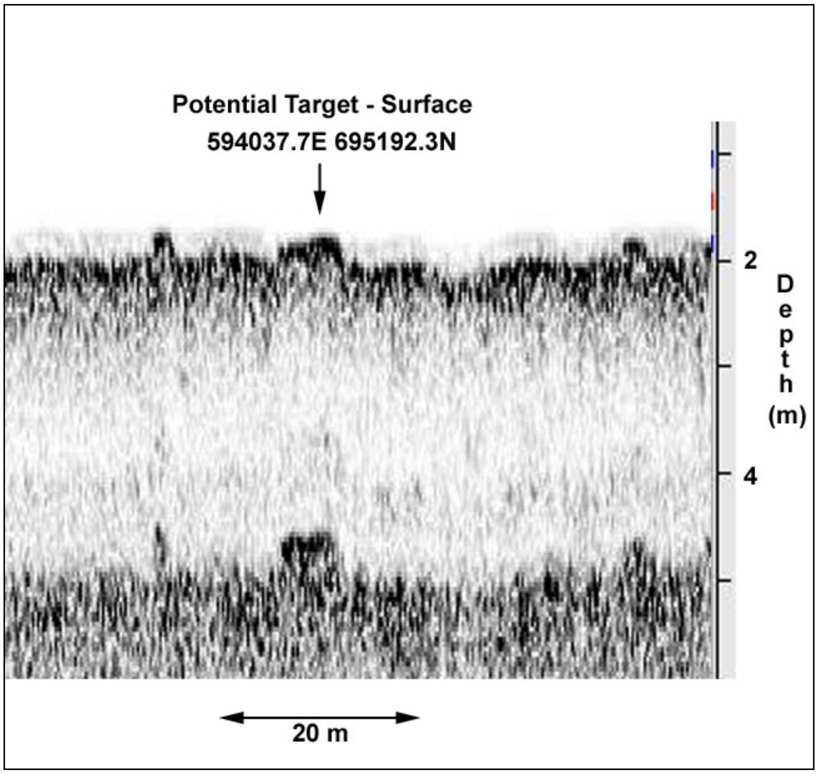


Figure 19. Potential target- surface (PS-1) that was identified during the chirp survey. This target is not associated with a magnetic anomaly. The location of this target is shown in Figure 2.

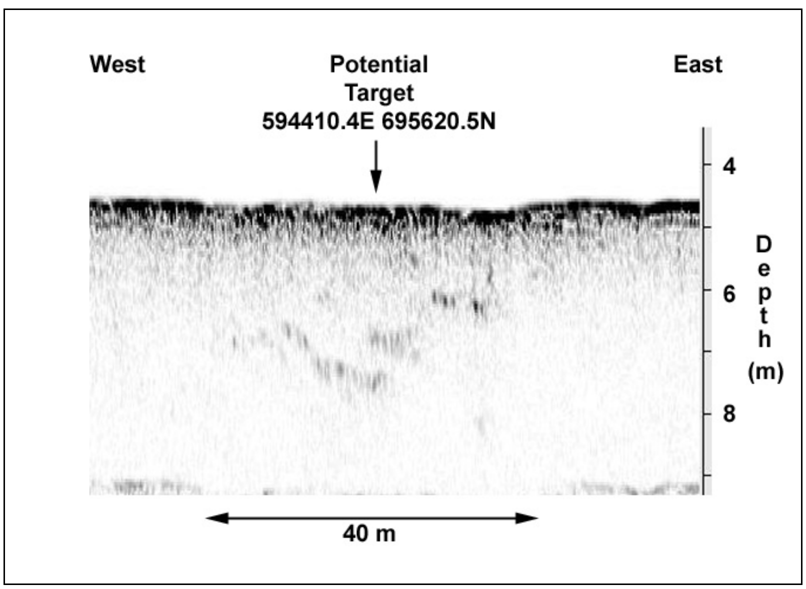


Figure 20. Potential target-sub-surface (PSS-1) that was identified during the chirp survey. This target is not associated with a magnetic anomaly. The location of this target is shown in Figure 2.

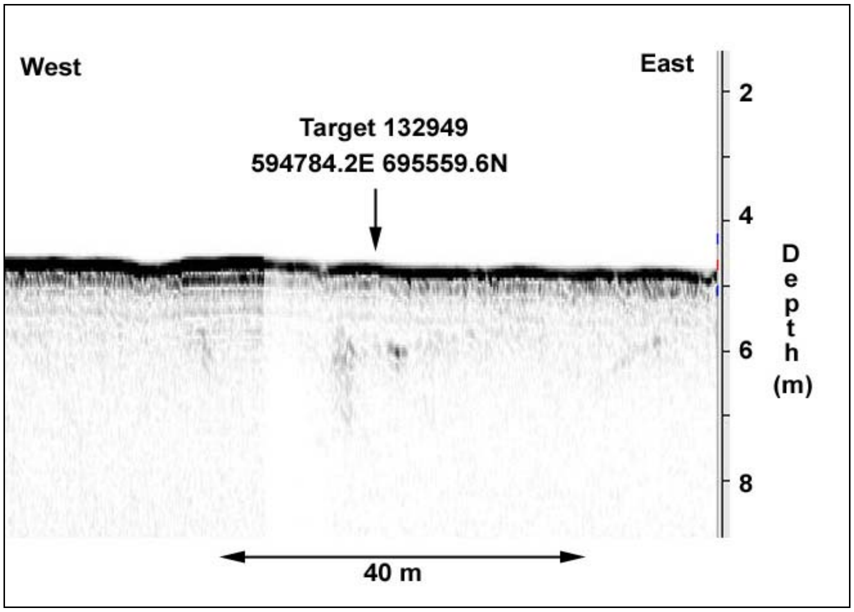


Figure 21. Target 132949 with associated chirp reflections. This target was identified during the magnetic survey. The location of this target is shown in Figure 2. The position in NAD83 New Jersey State Plane co-ordinates is the geographic central portion of the chirp reflections.

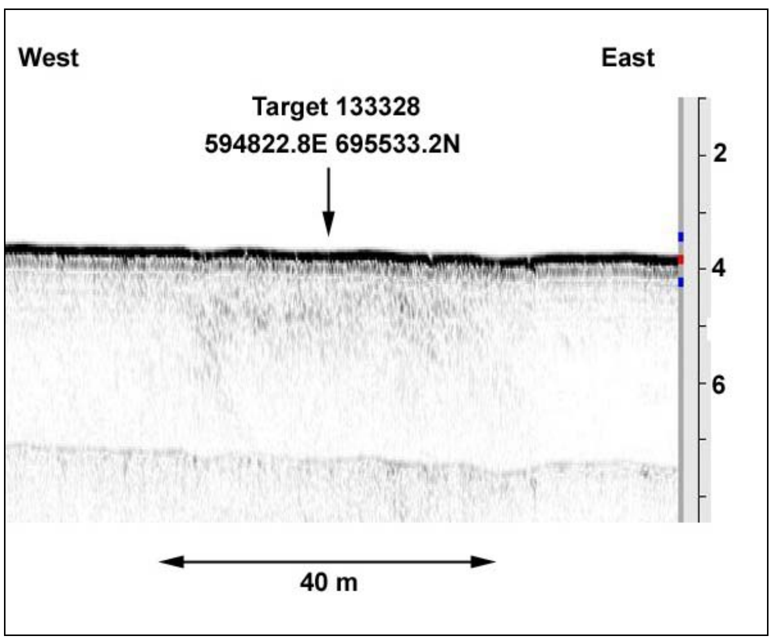


Figure 22. Target 133328 with associated chirp reflections. This target was identified during the magnetic survey. The location of this target is shown in Figure 2. The position in NAD83 New Jersey State Plane co-ordinates is the geographic central portion of the chirp reflections.

E. Problems Encountered

The only problem encountered with the magnetic remote sensing survey was the significant amount of geologic background noise encountered in the survey area. This results in magnetometer records that are more difficult to interpret and very small targets may be obscured. Though these objects would not be of significant size in relation to the dredging operations, they may be important from a submerged cultural resources standpoint. In order to minimize the effects of geologic interference, it is recommended that future magnetic surveys in this area be conducted using a gradiometer rather than a magnetometer.

In terms of using chirp acoustic methods to image targets as identified by the magnetic survey, there were two major problems that the river bottom presented in our survey. First, the acoustic reflection coefficient at the bottom surface in the area of the well-consolidated silt/clay sediments is high. This limited the amount of acoustic energy that penetrated deeper into the sub-bottom. Second, in areas of fine-grained silts and clays, there were high amplitude returns from the river bottom. Both of these bottom types were associated with the presence of organic-rich gaseous sediments in a layer that was mostly unbroken in the survey area. These muds, which may contain significant amounts of organically produced gas, created situations in which little acoustic energy traveled below these sediments. Due to these two conditions, the chirp system was unable to get significant penetration into the sub-bottom. This limited the effectiveness of the system to image targets in the sub-surface.

Appendix A

Chirp Profiles Within the Vicinity of 12 targets Identified in Magnetic Survey

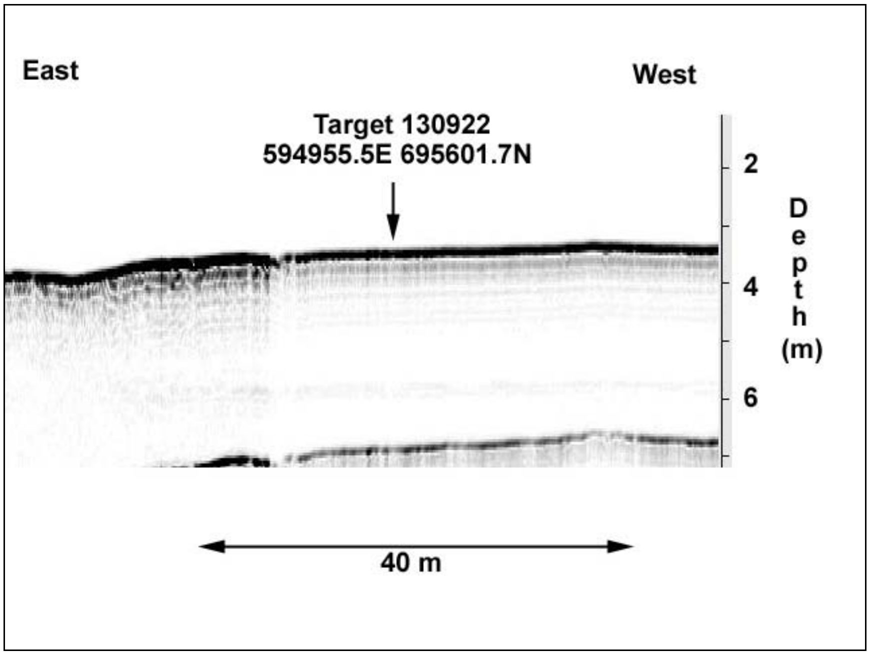


Figure A-1. Target 130922. Location of the target is shown in Figure 2.

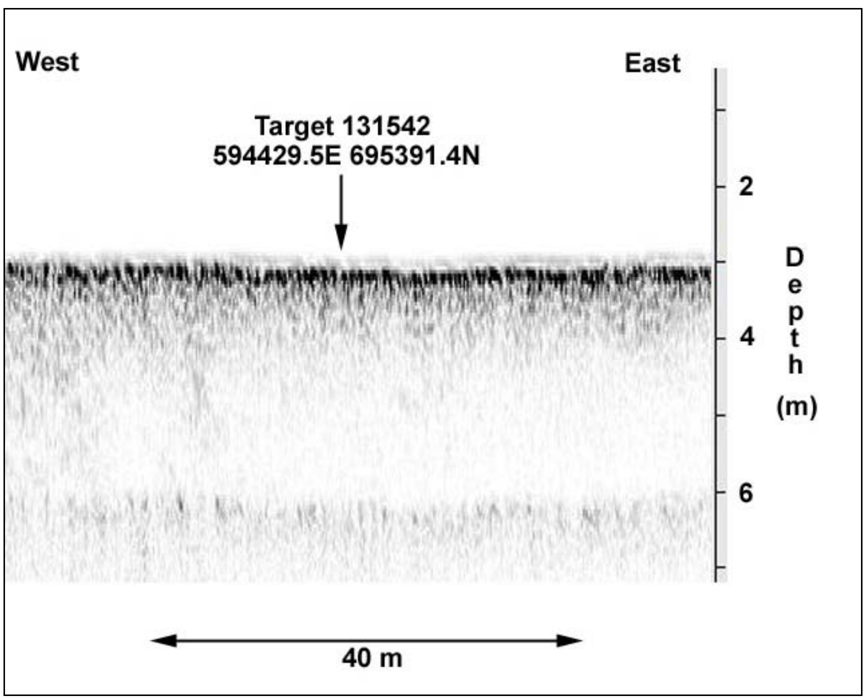


Figure A-2. Target 131542. Location of the target is shown in Figure 2.

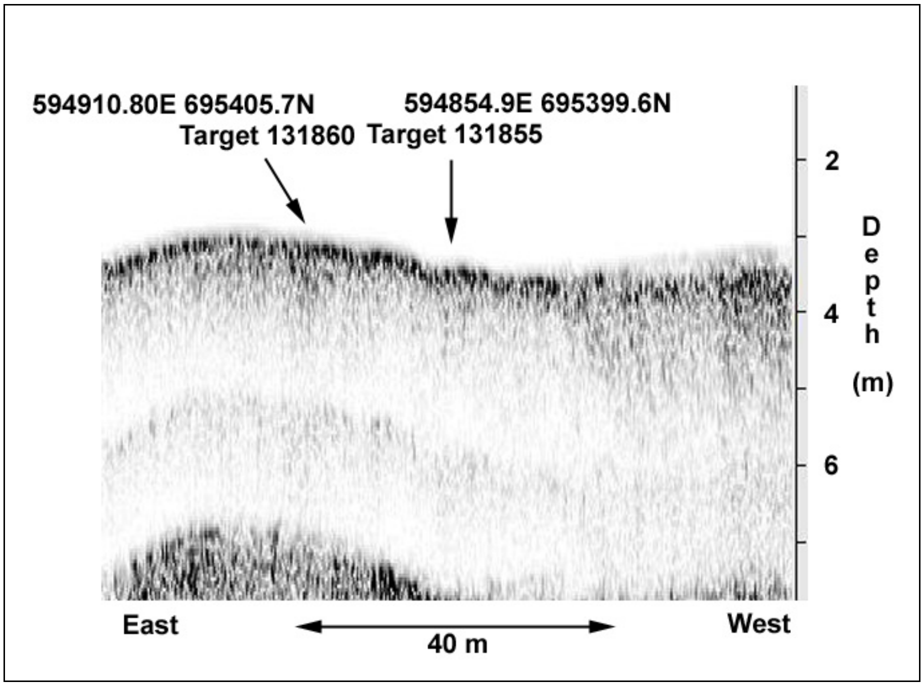


Figure A-3. Targets 131855 and 131860. Location of the targets is shown in Figure 2.

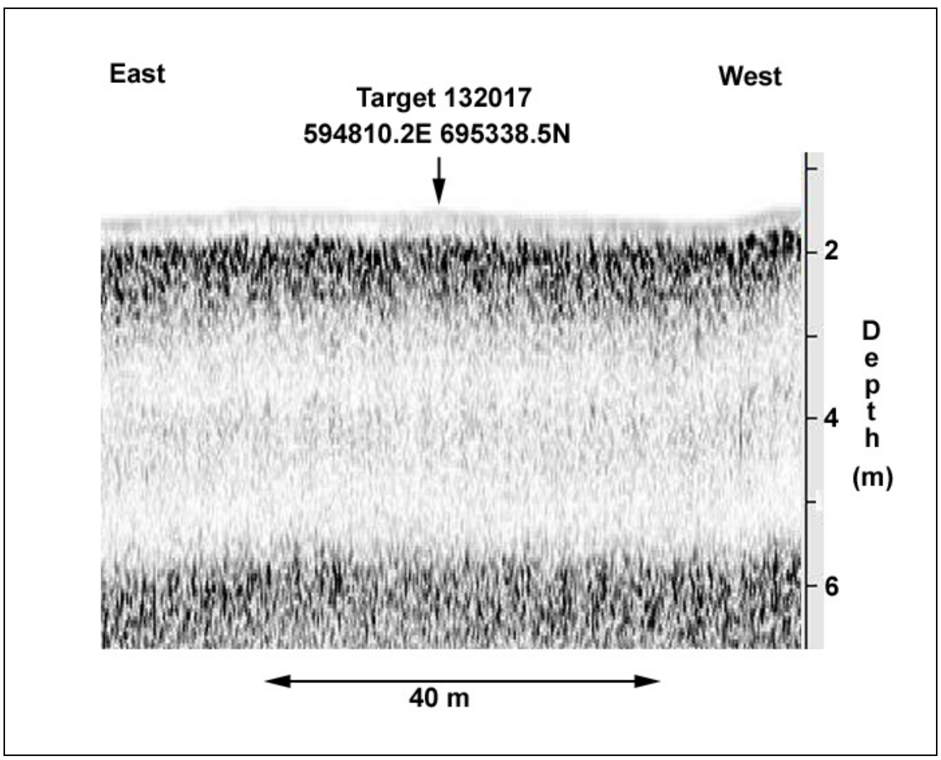


Figure A-4. Target 132017. Location of the target is shown in Figure 2.

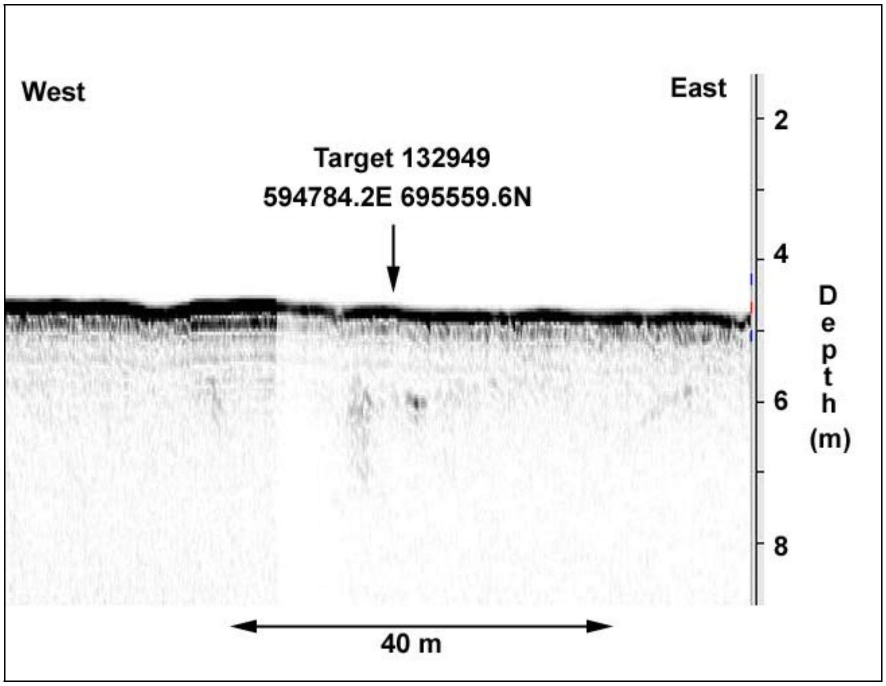


Figure A-5. Target 132949. Location of the target is shown in Figure 2.

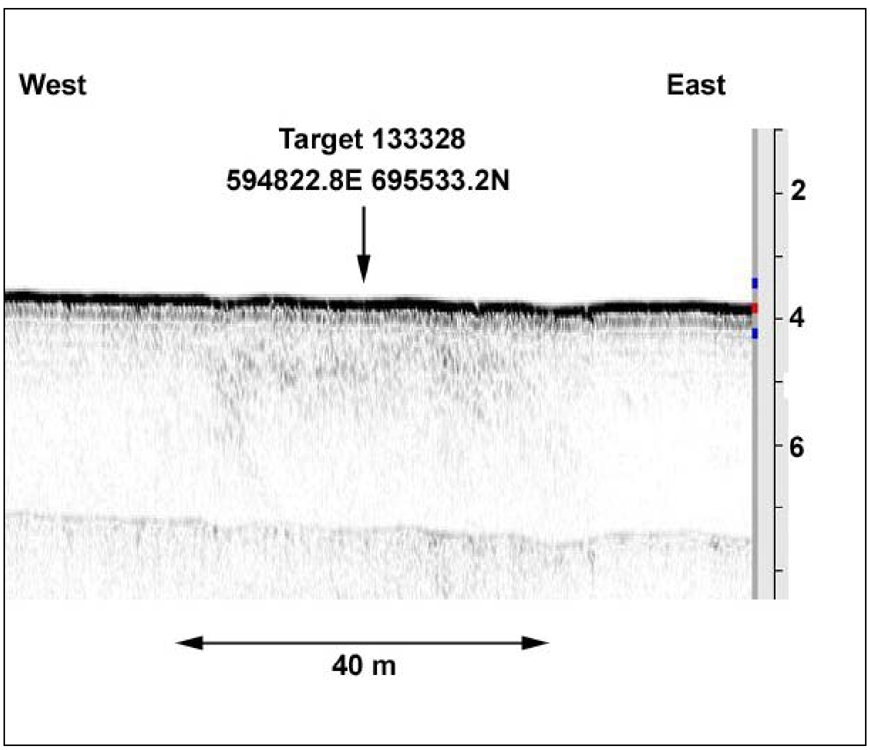


Figure A-6. Target 133328. Location of the target is shown in Figure 2.

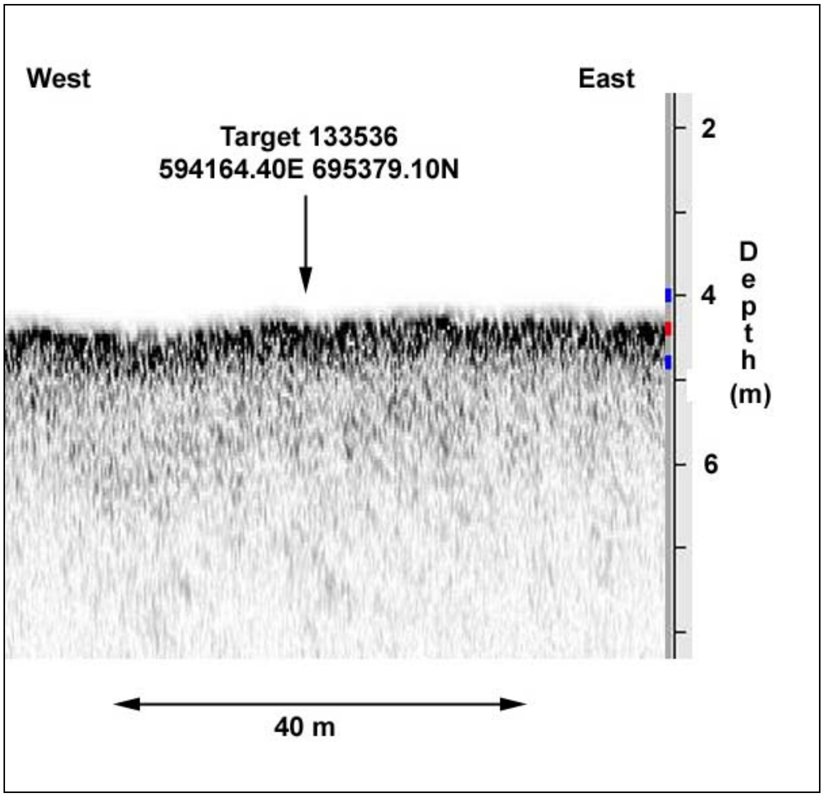


Figure A-7. Target 133536. Location of the target is shown in Figure 2.

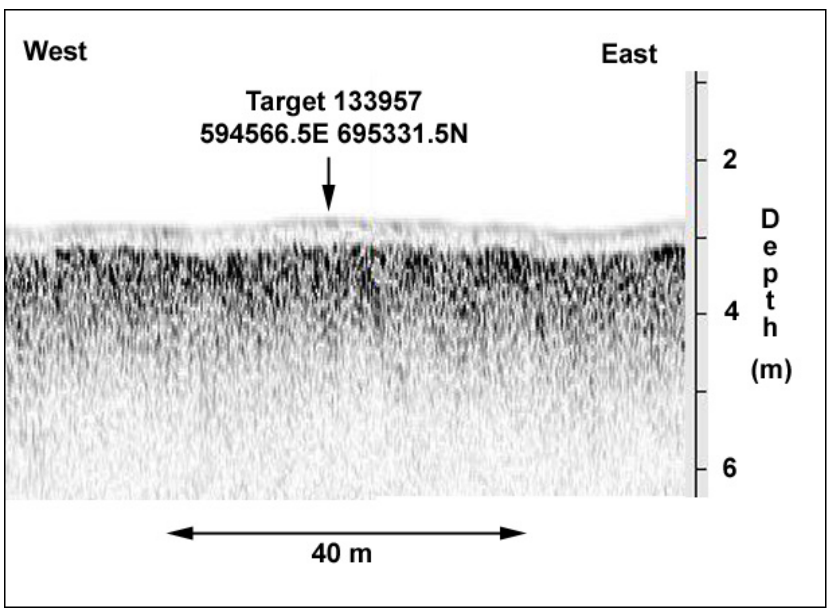


Figure A-8. Target 133957. Location of the target is shown in Figure 2.

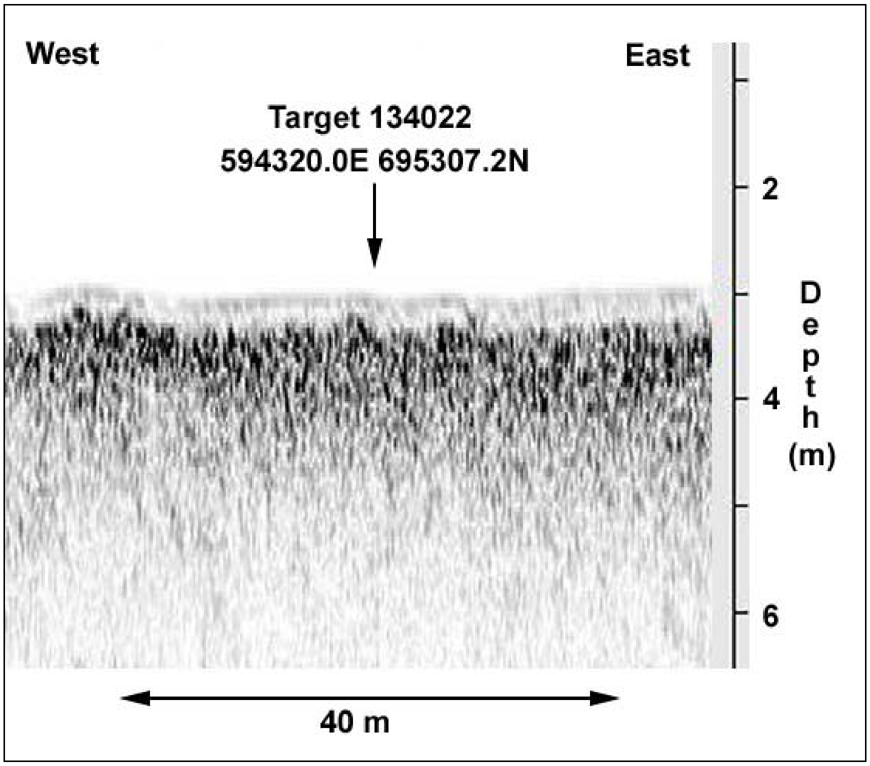


Figure A-9. Target 134022. Location of the target is shown in Figure 2.

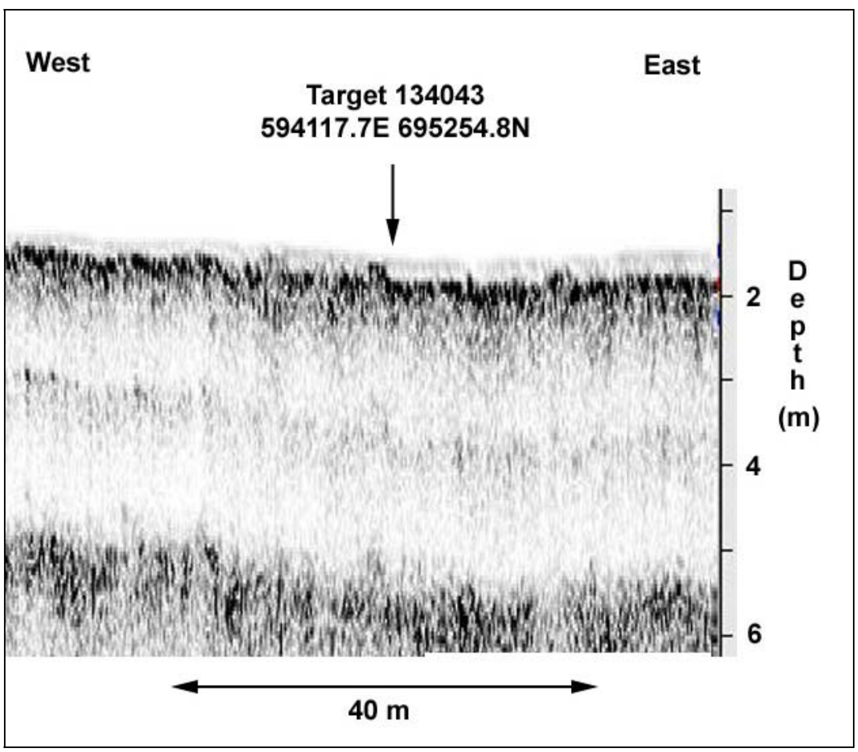


Figure A-10. Target 134043. Location of the target is shown in Figure 2.

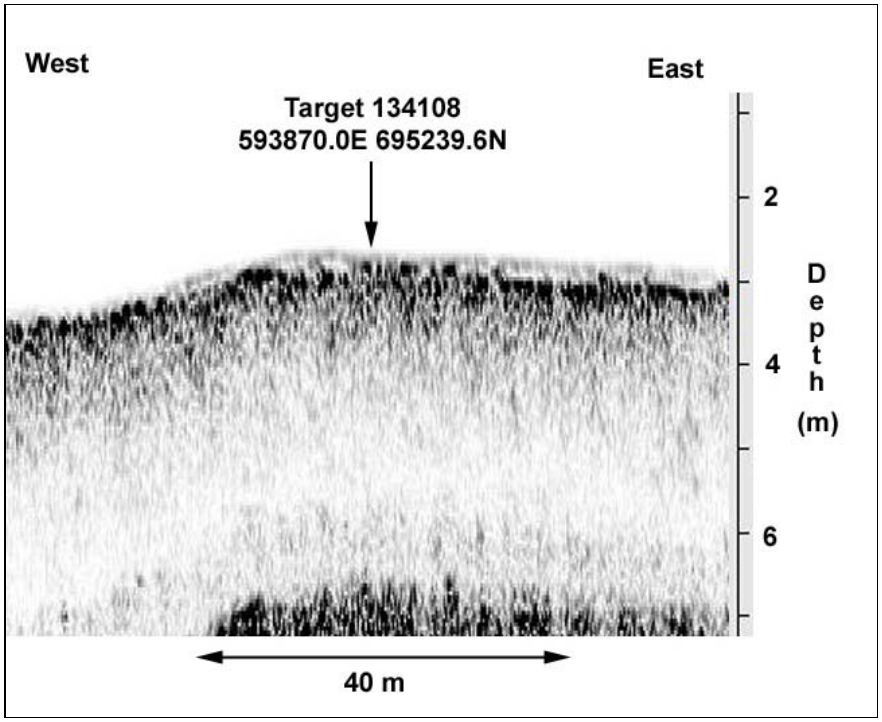


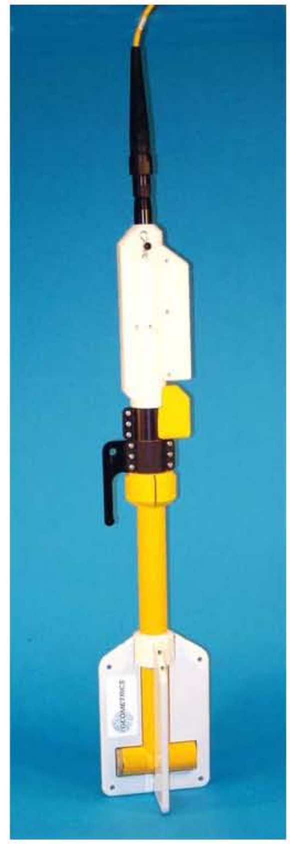
Figure A-11. Target 134108. Location of the target is shown in Figure 2.

Appendix B

Equipment Specifications

G-882 MARINE MAGNETOMETER

- ***CESIUM VAPOR HIGH PERFORMANCE – Highest detection range and probability of detecting all sized ferrous targets***
- ***NEW STREAMLINED DESIGN FOR TOW SAFETY – Low probability of fouling in lines or rocks***
- ***NEW QUICK CONVERSION FROM NOSE TOW TO CG TOW – Simply remove a stainless steel locking pin, move tow point and reinsert. New easy carry handle built in!***
- ***NEW INTERNAL CM-221 COUNTER MODULE – Provides Flash Ram for storage of default parameters set by user***
- ***NEW ECHOSOUNDER / ALTIMETER OPTION***
- ***NEW DEPTH RATING – 4,000 psi !***
- ***HIGHEST SENSITIVITY IN THE INDUSTRY – 0.004 nT/Hz RMS with the internal CM-221 Mini-Counter***
- ***EASY PORTABILITY & HANDLING – no winch required- single man operation, 44 lbs with 200 ft cable (without weights or depressor wing)***
- ***COMBINE TWO SYSTEMS FOR INCREASED COVERAGE – Internal CM-221 Mini-Counter provides multi-sensor data concatenation allowing side by side coverage which maximizes detection of small targets and reduces noise***



G-882 with Weight Collar Depth Option

Very high resolution Cesium Vapor performance is now available has been incorporated into a low cost, small size system for professional surveys in shallow or deep water. High sensitivity and sample rates of total field measurements are maintained for all applications. The well proven Cesium sensor is combined with a unique new CM-221 Larmor counter and ruggedly packaged for small or large boat operation. Use your computer and standard printer with our MagLog Lite™ software to log, display and print GPS position and magnetic field data. Model G–882 is the lowest priced - highest performance fully operational marine mag system ever offered.

The G-882 is flexible for operation in small boat, shallow water surveys as well as deep tow applications (4,000 psi rating, telemetry over steel coax available to 10Km). Being small and lightweight (44 lbs net, no weights) it is easily deployed and operated by one man. But add several no-foul weight collars and the system can quickly weigh in at more than 100 lbs. Power may be supplied from a 24 to 30 VDC battery supply or the included 110/220 VAC power supply. The tow cable uses high strength Kevlar and it's length is standard at 200 ft (61 m) with optional cable up to 500m (no telemetry). The shipboard end of the tow cable is attached to a junction box or on-board cable for quick and simple hookup to power and output of data into any IBM PC computer. A rugged fiber-wound fiberglass housing provides selectable orientation of the sensor and therefore maintains operations throughout the world with only small limitations as to direction of survey in equatorial regions.

The G-882 Cesium magnetometer provides the same operating sensitivity and sample rates as the larger deep tow model G-880. MagLogLite™ Logging Software is offered with each magnetometer and allows recording and display of data and position with Automatic Anomaly Detection! Additional options include: MagMap2000 plotting and contouring software and post acquisition processing software MagPick™ (free from our website.)

The G-882 system is particularly well suited for the detection and mapping of all sizes of ferrous objects. This includes anchors, chains, cables, pipelines, ballast stone and other scattered shipwreck debris, munitions of all sizes, aircraft, engines and any other object with magnetic expression. Objects as small as a 5 inch screwdriver are readily detected provided that the sensor is close to the seafloor and within practical detection range.(Refer to table at right).

The design of this special marine unit is directed toward the largest number of user needs. It is not intended to meet all marine requirements such as deep tow through long cables or monitoring fish altitude. Rugged design with highest performance at lowest cost are the goals.

Typical Detection Range For Common Objects

Ship 1000 tons	0.5 to 1 nT at 800 ft (244 m)
Anchor 20 tons	0.8 to 1.25 nT at 400 ft (120 m)
Automobile	1 to 2 nT at 100 ft (30 m)
Light Aircraft	0.5 to 2 nT at 40 ft (12 m)
Pipeline (12 inch)	1 to 2 nT at 200 ft (60 m)
Pipeline (6 inch)	1 to 2 nT at 100 ft (30 m)
100 KG of iron	1 to 2 nT at 50 ft (15 m)
100 lbs of iron	0.5 to 1 nT at 30 ft (9 m)
10 lbs of iron	0.5 to 1 nT at 20 ft (6 m)
1 lb of iron	0.5 to 1 nT at 10 ft (3 m)
Screwdriver 5 inch	0.5 to 2 nT at 12 ft (4 m)
1000 lb bomb	1 to 5 nT at 100 ft (30 m)
500 lb bomb	0.5 to 5 nT at 50 ft (16 m)
Grenade	0.5 to 2 nT at 10 ft (3 m)
20 mm shell	0.5 to 2 nT at 5 ft (1.8 m)

MODEL G-882 CESIUM MARINE MAGNETOMETER SYSTEM SPECIFICATIONS

OPERATING PRINCIPLE:	Self-oscillating split-beam Cesium Vapor (non-radioactive)
OPERATING RANGE:	20,000 to 100,000 nT
OPERATING ZONES:	The earth's field vector should be at an angle greater than 6° from the sensor's equator and greater than 6° away from the sensor's long axis. Automatic hemisphere switching.
CM-221 COUNTER SENSITIVITY:	<0.004 nT/$\sqrt{\text{Hz}}$ rms. Typically 0.02 nT P-P at a 0.1 second sample rate or 0.002 nT at 1 second sample rate. Up to 10 samples per second
HEADING ERROR:	±1 nT (over entire 360° spin and tumble)
ABSOLUTE ACCURACY:	<3 nT throughout range
OUTPUT:	RS-232 at 9600 Baud
MECHANICAL:	
Sensor Fish:	Body 2.75 in. (7 cm) dia., 4.5 ft (1.37 m) long with fin assembly (11 in. cross width), 40 lbs. (18 kg) Includes Sensor and Electronics and 1 main weight. Additional collar weights are 14lbs (6.4kg) each, total of 5 capable
Tow Cable:	Kevlar Reinforced multiconductor tow cable. Breaking strength 3,600 lbs, 0.48 in OD, 200 ft maximum. Weighs 17 lbs (7.7 kg) with terminations.
OPERATING TEMPERATURE:	-30°F to +122°F (-35°C to +50°C)
STORAGE TEMPERATURE:	-48°F to +158°F (-45°C to +70°C)
ALTITUDE:	Up to 30,000 ft (9,000 m)
WATER TIGHT:	O-Ring sealed for up to 9000 ft (2750 m) depth operation
POWER:	24 to 32 VDC, 0.75 amp at turn-on and 0.5 amp thereafter
ACCESSORIES:	
Standard:	CM-201 View Utility Software operation manual and ship case
Optional:	Telemetry to 10Km coax, gradiometer (longitudinal or transverse)
MagLog Lite™ Software:	Logs, displays and prints Mag and GPS data at 10 Hz sample rate. Automatic anomaly detection and single sheet Windows printer support

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE *4/03*

GEOMETRICS, INC. 2190 Fortune Drive, San Jose, California 95131
408-954-0522 ● Fax 408-954-0902 ● Internet: sales@mail.geometrics.com

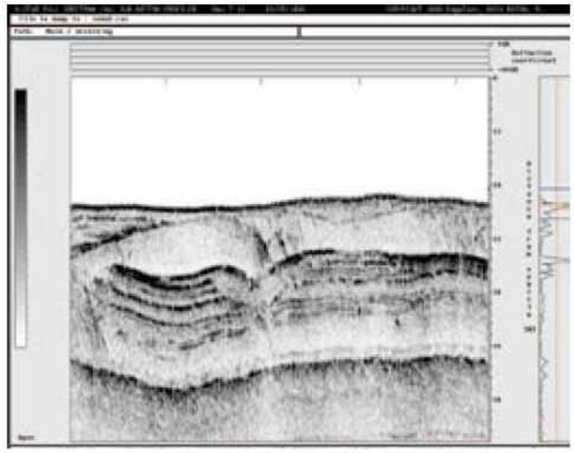
GEOMETRICS Europe Manor Farm Cottage, Galley Lane, Great Brickhill, Bucks, England MK179AB ● 44-1525-261874 ● Fax 44-1525-261867

GEOMETRICS China Laurel Industrial Co. Inc. - Beijing Office, Room 2509-2511, Full Link Plaza #18 Chaoyangmenwai Dajie, Chaoyang District, Beijing, China 100020
10-6588-1126 (1127..1130), 10-6588-1132 ● Fax 010-6588-1162

GEOMETRICS

FULL SPECTRUM
SUB-BOTTOM PROFILER

X-STAR



Unequalled images that combine good penetration and high resolution. 20-30 dB improved SNR over conventional systems by using Full Spectrum (FM) Pulses.

Sub-Bottom Profiler Shallow Tow System

X-STAR is a high resolution wideband Frequency Modulated (FM) sub-bottom profiler utilizing EdgeTech's proprietary FULL SPECTRUM™ CHIRP technology. The system transmits a FM pulse that is linearly swept over a full spectrum frequency range (for example 2-16 kHz for 20 milliseconds.) The acoustic return received at the hydrophones is passed through a pulse compression filter, generating high resolution images of the sub-bottom stratigraphy in oceans, lakes, and rivers.

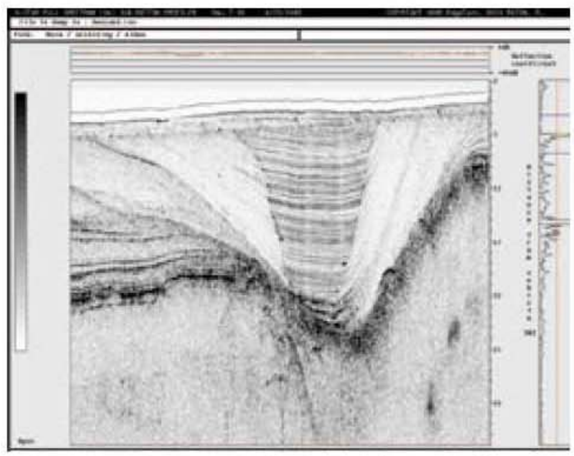
Because the FM pulse is generated by a digital to analog converter with a wide dynamic range and a transmitter with linear components, the energy, amplitude, and phase characteristics of the acoustic pulse are precisely controlled. This precision results in high repeatability and signal definition required for sediment classification.

Several stable, low drag tow vehicles are available that contain wide band transmitter arrays and sensitive line array receivers that can operate in water depths up to 300 meters. The selection of tow vehicle depends on the sub-bottom characteristics and resolution required.

Full Spectrum Benefits

FM pulses have been used in radar for over 30 years and are sometimes called chirp or swept frequency pulses. Its application in sonar systems has come with the availability of high speed Digital Signal Processors (DSP).

Full Spectrum signal processing technology uses a proprietary matched filter to process wideband signals. This matched filter uses special amplitude and phase weighting functions for the transmitted pulse and a pulse compression filter that maximizes the Signal to Noise Ration (SNR) of the acoustic images over a wide band of operating frequencies. These X-STAR signal processing features provide a significant SNR improvement in the acoustic image generated by other impulse and chirp sonars with band limiting components that are limited in dynamic range.



• EEZ resource development • Geo-technical surveys • Hazard surveys • Environmental site investigations • Geological studies • Sediment classification • Buried object location • Search and recovery • Locate and map buried pipelines and cables • Mining and dredging surveys • Bridge and shoreline scour surveys

EdgeTech®
THE SOUND SOLUTION

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Tel: (561) 995-7767 • Fax: (561) 995-7761
E-mail: sales@edgetech.com • Website: www.edgetech.com

One of the outstanding aspects of Full Spectrum signal processing is the use of a broad bandwidth transmitting pulse that sweeps out over a range of frequencies. This generates a great deal of acoustic energy in the water. Instead of trying to operate with one very sharp acoustic peak pulse, like conventional CW systems, the Full Spectrum sonar spreads the transmission out over a long time duration. In addition, to the resolution improvement, the process of correlation processing achieves a signal processing gain over the background noise. To equal the typical performance of the Full Spectrum sonar pulse, conventional pulsed sonar would have to operate at a peak pulse power 100 times higher than the Full Spectrum pulse.

Normally, when using long pulses the resolution of the seabed is lost. Resolution of the seabed is regained after correlation processing the received signal. This is because the output of the correlation is a very sharp wavelet that has duration of the order of the inverse of the sweep bandwidth. Thus, the more bandwidth used, the sharper this pulse will become.

Another important feature, which enhances the ability of the Full Spectrum Sub-bottom Profiler system to classify sediments, is realized by the built-in de-convolution of the system response from the output pulse. The sonar's system impulse response is measured at the factory and is used to design a unique output pulse that will prevent the source from ringing. In addition to this, the Full Spectrum wavelet is weighted in the frequency domain to have a Gaussian like shape. As the Gaussian shaped spectrum is attenuated by the sediment, energy is lost but its bandwidth is preserved. Thus, even after being attenuated by 20 meters of sand, the Full Spectrum pulse has approximately the same resolution as a non-attenuated pulse.

The Full Spectrum Sonar side lobes are greatly reduced in the effective transducer aperture. The wide bandwidth of the sweep frequency smears the side lobes of the transducer and thus achieving a beam pattern with virtually no side lobes. The effective spatial beam width obtained after processing the Full Spectrum sub-bottom pulse is typically 20 degrees measured to the -3db points. This feature is clear when inspecting the Full Spectrum records. Since the transmitted pulse is highly repeatable and its peak amplitude is precisely known, the sediment reflective values can be estimated from the peak pulse amplitude measurements of the bottom returns.

Use different tow vehicles for desired penetration and resolution. The topside portion remains the same. The FM pulse is user selected based on the sub-bottom conditions at the survey site and the type of sub-bottom features that need to be imaged.

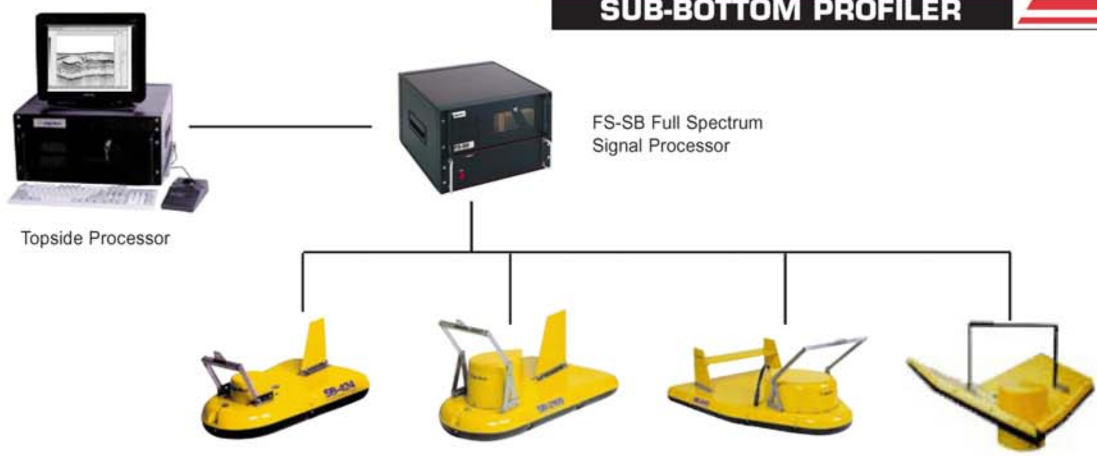
Configuration

The X-STAR sub-bottom profiler has a separate transmitter(s) constructed from wideband piston type transducers and separate acoustic receivers that are a discrete line array of PZT crystals. Separate receiving and transmitting arrays are used to preserve linearity and to allow simultaneous transmission and reception. The acoustic sensors are mounted in tow vehicles designed for profiling at ship speeds varying from 0 (drifting) to 7 knots.

X-STAR is designed for modular deployment. The heart of the system is a Signal Amplifier and Processor (Model FS-SB). It is here where the Full Spectrum signal is generated for output and filtered on reception. One of four tow vehicles may be connected. While EdgeTech supplies its own Topside Display Processor (Model TD-SB), it is also possible to interface other 3rd Party Topsides. EdgeTech has entered into agreements with several Topside Manufactures who support the EdgeTech Full Spectrum products.

Contact EdgeTech for X-STAR systems that are available in several other deployment options; Hull Mount, Deep Towed, ROV Mounted, and AUV/UUV Mounted.

FULL SPECTRUM
SUB-BOTTOM PROFILER



Towfish Model	SB-424	SB-216S	SB-0512	SB-0408
Frequency Range	4-24 kHz	2 - 16 kHz	500 Hz - 12 kHz	400 Hz - 8 kHz
Pulse Type	FM	FM	FM	FM
Standard Pulse Bandwidths / Length (other custom pulses available)	3-24 kHz / 10 ms 4-24 kHz / 10 ms 4-20 kHz / 10 ms 4-16 kHz / 10 ms	2-15 kHz / 20 ms 2-12 kHz / 20 ms 2-10 kHz / 20 ms	2-12 kHz / 20 ms 2-10 kHz / 20 ms 2-8 kHz / 40 ms 1.5-7.5 kHz / 40 ms 1-6 kHz / 40 ms 1-5 kHz / 40 ms 0.5-5 kHz / 40 ms	1.5-10 kHz / 20 ms 1-7 kHz / 40ms 1-6 kHz / 40 ms 0.7-4.5 kHz / 40 ms 0.6-3.0 kHz / 40 ms 0.4-2.4 kHz / 40 ms
Vertical Resolution	4 cm / 4-24 kHz 6 cm / 4-20 kHz 8 cm / 4-16 kHz	6 cm / 2-15 kHz 8 cm / 2-12 kHz 10 cm / 2-10 kHz	8 cm / 2-12 kHz 12 cm / 1.5–7.5 kHz 19 cm / 1- 5 kHz	9 cm / 1.5 kHz-10 kHz 15 cm / 1-6 kHz 37 cm / 0.4-2.4 kHz
Penetration (typical)				
in coarse calcareous sand	2	6	20	40
in clay	40	80	200	300
Beam Width (depends on center frequency)	16° / 4-24 kHz 19° / 4-20 kHz 23° / 4-16 kHz	17° / 2-15 kHz 20° / 2-12 kHz 24° / 2-10 kHz	16° / 2-12 kHz 24° / 1.5–7.5 kHz 32° / 1- 6 kHz	10° / 1.5 kHz-10 kHz 14° / 1-7 kHz 37° / 0.4-2.4 kHz
Transmitters	1	1	4	2
Receive Arrays	2	2	4	8
Size (centimeters)	77L x 50W x 34H	105L x 67W x 46H	210L x 134W x 46H	249 L x 214W x 91
Weight (kilograms)	22	44	186	364
Shipping weight (kg.)	82	122	288	consult factory
dimension (cm.)	L89 x W64 x H54	L115 x W79 x H59	L172 x W137 x H58	
Cable Requirements	3 shielded twisted pairs (5 used)	same	same	3 shielded twisted pairs (all used)
Max Depth (meters)	300	300	300	300
GeoStar Interface	Yes	Yes	No	No

Other System Specifications

Tow Speed	3-5 knots optimal, 7 knots maximum safe operational
MaximumTow Fish Operating Depth	300 meters (1,000 feet)
Optimum tow height	3 to 5 meters above seafloor
Calibration	Each system is acoustic tank tested to calibrate for reflection coefficient measurements

FULL SPECTRUM
SUB-BOTTOM PROFILER

FS-SB Full Spectrum Processor

Main Processor	Intel CPU with high speed PCI bus
Digital Signal Processor	TMS320
Memory	32 MB RAM
Storage	Hard drive, CD-ROM, floppy disk
Operating System	Windows® 98
I/O to Topside Processor	Ethernet
A/D	Analog Input, 16 bit resolution, 200 kHz max. sampling rate
D/A	Analog Output,16 bit resolution, 200 kHz max. sampling rate
Pulse Type	Full Spectrum (Frequency Modulated with amplitude and phase weighting)
Pulse Trigger	Internal or External
Pulse Repetition	0.5 to 12 Hz
Trigger In	TTL negative edge triggered (Middle BNC)
Trigger Out	TTL negative edge triggered. Minimum 5ms long pulse (Lower BNC)
Sampling Rate	Typically 20, 25, 40, or 50 kHz depending on the pulse upper frequency
Acoustic Power	212 dB ref 1μPa peak at center frequency of system
Input Power	120 or 220 VAC Auto Sensing
Power Amplifier	Type: Two channel, Gain: 33dB per channel, Power output: 2000 Watts peak, Power input: 110-120V/60Hz or 220-240 V/50Hz Manually Switchable
Topside Display Processors w/ Support	EdgeTech, CODA Technologies Ltd., Sea Corp., TEI Inc.
Environment	Temperature: 0 to 40°C, Humidity: 5% to 95% relative, Vibration: Normal ship environment
Enclosure	Portable steel case suitable for transit. Unit can be removed from case and mounted in a 19" rack. Size: 50W x 60D x 33H cm. (19.5x23.5x13 in), Weight: 46 kg (102 lbs.)
Shipping Containers	Size: 109L x 79W x 71H cm. (43x31x28 in), Weight: 150 kg (330 lbs.) Material: Sealed high impact polyurethane case

EdgeTech Topside Display Processor

Options	Diagnostics Kit (Video Display, Keyboard, Mouse), Spare Parts Kit, Optional Pulses
Main processor	SPARC Workstation
Operating System	UNIX
Display	17" Color Monitor
Operator Controls	A/D Gain, Two Stage TVG, Bottom Tracking, Digital Gain, Preamplifier Gain, Horizontal and Vertical Zoom, Direct Path Suppression, Swell Filter, Annotation
Video Displays	Bottom Tracking, Reflection Coefficient, Signal Amplitude, Navigation Map, Scale Lines, Track Lines
Navigation	NMEA 0183, X/Y, N/E, Navigation I/O Utility, Track lines, Event/Fix Marks, Sediment Classification Color vs. Echo Strength
Annotation	Keyboard, RS232 Port
Event Mark	Via Keyboard, Switch Closure, RS232 Port
Printer Support	EPC Models 9800, 8300, 1086, HSP-100, ODECO Model 850 & 1200F, Alden Model 9315 CTP, Ultra Model 183/200
Mass Storage	DAT
I/O Ports	Ethernet, Serial, SCSI, Parallel, Event Mark, Keyboard, Trackball, External Trigger In, Trigger Out, Heave Compensation Input
Power	105-125VAC or 210-250VAC, selectable, 47-63 Hz
Enclosure	Portable steel case suitable for transit. May be removed from cases and installed in 19-inch rack. Size: 50.3W x 50.3D x 15.3H cm. (19.8 x 19.8 x 6 in.), Weight: 32 kg (71 lbs.)
Environment	Temperature: Operating 5°C to 40°C Non-operating -40°C to 45°C. Humidity: Operating 20% to 80% relative humidity, non-condensing. Non-operating 5%-95%. Vibration: Normal ship environment.
Options	Spare Parts Kit, Replay Software, Ethernet Output of Data, Dual Mass Storage, Software Services Agreement

Specifications subject to change without notice.

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THE SOUND SOLUTION

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MS750

Dual Frequency RTK Receiver for Precise Dynamic Positioning

Key features and benefits

- **20 Hz position update rate**
- **Less than 20 milliseconds position latency**
- **Centimeter-level position accuracy**
- **Front panel display & keypad for status monitoring and configuration**
- **User-defined local coordinates direct from receiver**
- **Industry standard CAN bus interface**

Trimble

The MS750™ represents the highest level of accuracy and response available from a dual frequency GPS receiver. The receiver is specifically designed to allow the easy integration of reliable centimeter-level positions to any guidance or control application.

Dual Frequency RTK Receiver for Precise Dynamic Positioning

Accuracy and Response Times

Dynamic platforms, require virtually instantaneous position reports multiple times per second. The MS750 delivers positions to guidance or control loop software twenty times per second with a latency of less than 20 milliseconds. This responsiveness is matched with a horizontal accuracy of two centimeters and vertical accuracy of three centimeters. For the most precise applications, the MS750 provides one centimeter accuracy horizontally at a 5 Hz rate with a small increase in latency.

Interfacing and Configuration Ease

The MS750 is designed to plug right into your application with minimal development. An easy to-use application file interface enables the user to completely program receiver operation with a single command. Alternately, the receiver can be configured via the user-friendly built-in display and keyboard interface, or by the included Windows-based Configuration Toolbox software. Multiple configurations can be stored in the receiver as files and activated when desired. Local datum and transformation parameters may be loaded directly into the receiver. Therefore, output grid coordinates are compatible with GPS and traditional survey systems that may be in use on the same site. ASCII or Binary messages may be output through any of the three bi-directional serial ports. The receiver also includes support for the industry standard CAN (Controller Area Network) interface.

Advanced Technology

The accuracies, update rates and latencies available in the MS750 are made possible through a GPS architecture specifically designed for demanding dynamic positioning applications. Reliable operation in the most adverse environments, such as radio interference experienced at construction or mining sites, is a strict requirement. Custom designed hardware with Supertrak™ multibit GPS signal technology and Everest™ advanced multipath suppression provide superior tracking especially for weaker, low elevation satellites.

Both the RTCM format for differential GPS corrections and Trimble's published Compact Measurement Record (CMR) differential data can be received simultaneously, allowing the receiver to choose the optimum source and provide seamless navigation. Available as an option is the ability to calculate the baseline vector between two moving receivers to centimeter accuracy. The MS750 addresses a vast range of applications in the field of machine positioning, guidance and control.

MS750

Dual Frequency RTK Receiver for Precise Dynamic Positioning

STANDARD FEATURES

- Centimeter accuracy, real-time positioning
- 20 Hz position updates
- < 20 ms position latency
- Front panel display & keypad
- User-defined local coordinates direct from receiver
- 3 serial I/O ports
- 2 CAN ports
- 1 PPS Output
- Trimble CMR Input/Output
- RTCM Input/Output
- One year hardware warranty
- Compact, easy mounting design
- Synchronized 5 Hz position updates

OPTIONS AND ACCESSORIES

- Moving Base RTK
- Rugged L1/L2 machine mount antenna
- Micro-Centered Antenna
- 5 m, 7.5 m, 10 m, 24 m & 30 m antenna cables
- Data extension cable
- Extended hardware warranty
- Firmware and Software update service

ORDERING INFORMATION

MS750 **Part Number 36577-00**

Includes MS750 receiver, Configuration Toolbox software, operating manual, power/data cable, data/1 PPS cable

PHYSICAL CHARACTERISTICS

Size	14.5cmW × 5.1cmH × 23.9cmD (5.7"W × 2.0" H × 9.4"D)
Weight	1.0 kg (2.25 lbs)
Power	12VDC/24VDC, 9 Watts

ENVIRONMENTAL CHARACTERISTICS

Operating temp	-20°C to +60°C
Storage temp	-30°C to +80°C
Humidity	MIL 810 E, Meth. 507.3 Proc III, Aggravated, 100% condensing
Vibration	MIL 810 D, Tailored Random 3gRMS Operating Random 6.2gRMS Survival
Mechanical Shock	MIL 810 D ± 40 g Operating ± 75 g Survival
EMC	
Radiated Emissions	CISPR 12
Conducted Emissions	SAE J1113/41
Radiated Immunity	ISO/DIS 13766, 30V/m
ESD	±15KV
Input Voltage Transients	ISO 7637-2

TECHNICAL SPECIFICATIONS

Tracking	9 channels L1 C/A code, L1/L2 full cycle carrier Fully operational during P-code encryption		
Signal processing	Supertrak Multibit Technology Everest Multipath Suppression		
Positioning mode	**Accuracy**[1]	**Latency**[2]	**Max Rate**
Synchronized RTK	1cm+ 2ppm Horizontal 2cm+ 2 ppm Vertical	300ms[3]	5 Hz Std
Low Latency	2cm+ 2ppm Horizontal[4] 3cm+ 2 ppm Vertical	< 20ms	20Hz
DGPS	< 1m	< 20ms	20Hz

[1] 1 sigma level
[2] At maximum output rate
[3] Dependent on data link throughput
[4] Assumes 1 second data link delay

Initialization	Automatic OTF (on-the-fly) while moving
Time required	Typically < 1 minute
Range	Up to 20 km from base for RTK
Start-up	< 90 seconds from power on to positioning < 30 seconds with recent ephemeris
Communications	3 × RS-232 ports. Baud rates up to 115,200 2 × CAN/J1939
Configuration	Via front panel display & keypad, Configuration Toolbox Software or user definable application files
Output Formats	NMEA-0183: GGK, GGA, ZDA, VTG, GST, PJT and PJK Trimble Binary Streamed Output

Trimble.

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YOUR LOCAL TRIMBLE OFFICE OR REPRESENTATIVE

Trimble 5700 GPS System

One receiver, many configurations, for greater flexibility and choice

The Trimble® 5700 GPS receiver is an advanced, but easy-to-use, surveying instrument that is rugged and versatile enough for any job.

Combine your 5700 with the antenna and radio that best suit your needs, and then add the Trimble controller and software of your choice for a total surveying solution. The powerful 5700 GPS system will provide all the advanced technological power and unparalleled flexibility you need to increase your efficiency and productivity in any surveying environment.

Advanced GPS receiver technology

The 5700 is a 24-channel dual-frequency RTK GPS receiver featuring the advanced Trimble Maxwell™ technology for superior tracking of GPS satellites, increased measuring speed, longer battery life through less power use, and optimal precision in tough environments. WAAS and EGNOS capability lets you perform real-time differential surveys to GIS grade without a base station.

Modular design for versatility

For topographic, boundary, or engineering surveying, clip the receiver to your belt, carry it in a comfortable backpack, or configure it with all components on a lightweight range pole. With the receiver attached to your site vehicle, you can survey a surface as fast as you can drive! For control applications, attach the receiver to a tripod...it's designed to work the way your job requires.

Full metal jacket...and lightweight

The 5700 GPS receiver boasts the toughest mechanical and waterproofing specs in the business. Its magnesium alloy case is stronger than aluminum, but also 30% lighter—the 5700 weighs just 1.4 kg (3 lb) with batteries. Whether you're collecting control points on a tripod, or scrambling down a scree slope collecting real-time kinematic data, the receiver is light enough and tough enough to carry on performing.

Fast and efficient data storage and communications

Use the receiver's CompactFlash memory to store more than 3,400 hours of continuous L1/L2 data collection at an average of 15-second intervals. Transfer data to a PC at speeds of more than 1 megabit per second through the super-fast USB port. Your choice of UHF radio modem is built in to the receiver to provide RTK communications receiving without the need for cables or extra power!

Your choice of Trimble antenna

Choose the high-accuracy Trimble GPS antenna that best suits your needs: the lightweight and portable Zephyr™ antenna for RTK roving, or the Zephyr Geodetic™ antenna for geodetic surveying.

The Zephyr Geodetic antenna offers submillimeter phase center repeatability and excellent low-elevation tracking, while the innovative design of its Trimble Stealth™ ground plane literally burns up multipath energy using technology similar to that used by stealth aircraft to hide from radar. The Zephyr Geodetic antenna thus provides unsurpassed accuracy from a portable antenna.

Key Benefits

- Industry-leading technology provides superior performance
- Flexible configurations put you in total control
- Rugged, high-performance hardware is built to last
- With the Trimble controller and software of your choice, enjoy seamless integrated surveying

Trimble.

Trimble 5700 GPS System

General

- Front panel for on/off, one-button-push data logging, CompactFlash card formatting, ephemeris and application file deletion, and restoring default controls
- LED indicators for satellite tracking, radio-link, data logging, and power monitoring
- Tripod clip or integrated base case

Performance specifications

Measurements

- Advanced Trimble Maxwell technology
- High-precision multiple correlator L1 and L2 pseudorange measurements
- Unfiltered, unsmoothed pseudorange measurement data for low noise, low multipath error, low time domain correlation, and high dynamic response
- Very low noise L1 and L2 carrier phase measurements with <1 mm precision in a 1 Hz bandwidth
- L1 and L2 Signal-to-Noise ratios reported in dB-Hz
- Proven Trimble low-elevation tracking technology
- 24 Channels L1 C/A Code, L1/L2 Full Cycle Carrier, WAAS/EGNOS.

Code differential GPS positioning[1]

Horizontal . . . . . ±(0.25 m + 1 ppm) RMS
Vertical . . . . . ±(0.5 m + 1 ppm) RMS
WAAS differential positioning accuracy typically <5 m 3DRMS[2]

Static and FastStatic GPS surveying[1]

Horizontal . . . . . ±5 mm + 0.5 ppm RMS
Vertical . . . . . ±5 mm + 1 ppm (× baseline length) RMS

Kinematic surveying[1]

Real-time and postprocessed kinematic surveys
Horizontal . . . . . ±(10 mm + 1 ppm) (× baseline length) RMS
Vertical . . . . . ±(20 mm + 1 ppm) RMS
Initialization time . . . . . Single/Multi-base minimum 10 sec + 0.5 times baseline length in km, up to 30 km
Scalable GPS infrastructure initialization time . . . . . <30 seconds typical anywhere within coverage area
Initialization reliability[3] . . . . . Typically >99.9%

Hardware

5700 GPS receiver

Physical:
Casing . . . . . Tough, lightweight, fully sealed magnesium alloy
Waterproof . . . . . Tested to IPX7 standards
Shock and vibration . . . . . Tested and meets the following environmental standards:
Shock . . . . . MIL-STD-810F to survive a 1 m (3.28 ft) drop onto concrete
Vibration . . . . . MIL-STD-810-F on each axis
Weight . . . . . With internal batteries, internal radio, internal battery charger, standard UHF antenna: 1.4 kg (3 lb)
As entire RTK rover with batteries for greater than 7 hours, less than 4 kg (8.8 lb)
Dimensions (W×H×L) . . . . . 13.5 cm × 8.5 cm × 24 cm (5.3 in × 3.4 in × 9.5 in)

Electrical:
Power . . . . . DC input 11 to 28 V DC with over voltage protection
Power consumption . . . . . 2.5 W receiver only, 3.75 W including internal radio
Battery . . . . . Greater than 10 hours data logging, or greater than 7 hours of RTK operation on two internal 2.0 Ah lithium-ion batteries
Battery weight . . . . . 0.1 kg (3.5 oz)
Battery charger . . . . . Internal with external AC power adapter; no requirement for external charger
Power output . . . . . 11.5 to 20 V DC (Port 1), 11.5 to 27.5 V DC (Port 3) on external power input
Certification . . . . . Class B Part 15 FCC certification, CE Mark approved, C-Tick approved, Canadian FCC

Environmental:
Operating temperature[4] . . . . . –40 °C to 65 °C (–40 °F to 149 °F)
Storage temperature . . . . . –40 °C to 80 °C (–40 °F to 176 °F)
Humidity . . . . . 100%, condensing

Communications and data storage:

- 2 external power ports, 2 internal battery ports, 3 RS232 serial ports
- Integrated USB for data download speeds in excess of 1 Mb per second
- External GPS antenna connector
- CompactFlash advanced lightweight and compact removable data storage. Options of 64 MB or 128 MB from Trimble
- More than 3,400 hours continuous L1+L2 logging at 15 seconds with 6 satellites typical with 128 MB card
- Fully integrated, fully sealed internal UHF radio modem option
- GSM, cellphone, and CDPD modem support
- Dual event marker input capability
- 1 Hz, 2 Hz, 5 Hz, and 10 Hz positioning and data logging
- 1 pulse per second output capability
- CMRII, CMR+, RTCM 2.*x* and 3.*x* input and output standard
- 14 NMEA outputs

Zephyr antenna

Dimensions . . . . . 16.2 cm (6.38 in) diameter × 6.2 cm (2.44 in) height
Weight . . . . . 0.55 kg (1.20 lb)
Operating temperature . . . . . –40 °C to 70 °C (–40 °F to 158 °F)
Humidity . . . . . 100% humidity proof, fully sealed
Shock and vibration . . . . . Tested and meets the following environmental standards:
Shock . . . . . MIL-STD-810-F to survive a 2 m (6.56 ft) drop onto concrete
Vibration . . . . . MIL-STD-810-F on each axis

- 4-point antenna feed for submillimeter phase center repeatability
- Integral low noise amplifier
- 50 dB antenna gain

Zephyr Geodetic antenna

Dimensions . . . . . 34.3 cm (13.5 in) diameter × 7.6 cm (3 in) height
Weight . . . . . 1.31 kg (2.88 lb)
Operating temperature . . . . . –40 °C to 70 °C (–40 °F to 158 °F)
Humidity . . . . . 100% humidity proof, fully sealed
Shock and vibration . . . . . Tested and meets the following environmental standards:
Shock . . . . . MIL-STD-810-F to survive a 2 m (6.56 ft) drop onto concrete
Vibration . . . . . MIL-STD-810-F on each axis

- 4-point antenna feed for submillimeter phase center repeatability
- Integral low noise amplifier
- 50 dB antenna gain
- Trimble Stealth ground plane for reduced multipath

1 Accuracy may be subject to conditions such as multipath, obstructions, satellite geometry, and atmospheric parameters. Always follow recommended survey practices.
2 Depends on WAAS/EGNOS system performance.
3 May be affected by atmospheric conditions, signal multipath, and satellite geometry. Initialization reliability is continuously monitored to ensure highest quality.
4 Receiver operates normally to –40 °C (–40 °F) but some office-based functions such as USB download or internal battery charging are not recommended at temperatures below freezing.
Specifications subject to change without notice.

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